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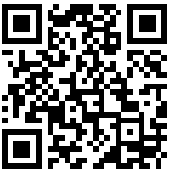

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Maj.-Gen. H. L. Pritchard, C.B., C.M.G., D.S.O., 1926
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Maj.-Gen. *Sir* Sydney D'A. Crookshank, K.C.M.G., C.B., C.I.E., D.S.O., M.V.O. 1926
Major G. E. H. Sim, D.S.O., M.C. 1926
Col. C. G. Ling, D.S.O., M.C. 1926
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Secretary: Lieut.-Col. P. H. Kealy, 1st October, 1927.

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AIRSHIP DEVELOPMENT.

A Lecture delivered at the S.M.E., Chatham, on 22nd November, 1928, *by* GROUP CAPTAIN P. F. M. FELLOWES, D.S.O., *A.D.C.*, R.A.F.

I FEEL much honoured to have been asked to lecture on the present development of British airships in what is essentially their source of origin. One of your Corps, who has been connected with airship development for over 25 years, is still with us, and occupies the important position of Chief Inspector of the Aircraft Inspection Department for the Cardington airship.

The subject of airships is a somewhat wide one to endeavour to include in a single lecture, and naturally divides itself into four subdivisions: *Construction, Operation, Commercial Uses* and *War Uses.*

Before I deal with these headings, you would probably like to be reminded of the main points of our present programme. We are building two 5,000,000 cubic ft. rigid airships, one at Howden and one at Cardington, and are laying out sheds (docks) and mooring towers (harbours) at suitable places within the Empire, to enable these ships to be fully tried out in varying climatic conditions. At the same time, the necessary meteorological investigations are taking place, and arrangements are being made to instal adequate communications. Summarized, the main object of the programme is to prove to the business community that airship hulls can be built strong enough to operate regularly, and that therefore airships are worth while from an economic point of view.

CONSTRUCTION.

Taking construction first, I will show you some slides of the various types of ships which have been built with the purpose of bringing out their main differences. Before I show you these slides, I will remind you that the lift of hydrogen at ground level under standard conditions is 68 lb. per 1,000 cubic feet, a convenient figure to remember is that 33,000 cubic feet will lift a ton. The buoyancy of an airship is equal to the weight of air she displaces. It therefore decreases as the air density decreases with increase of temperature or height. Consequently an airship has less lift or gas capacity in hot climates or at heights, than in cold weather or at ground level. By flying an airship bow up or bow down, an upward or downward

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dynamic lift may be produced, which in R.101 at full speed will amount to 15–20 tons.

My main object in showing you this series of slides is first broadly to emphasize the different types of ships and then to bring out the development of shape which has since taken place in the rigid. The originator of the rigid design, as you all know, was Count Zeppelin, and in the first instance he built a long, cigar-shaped, parallel-sided airship, as being the easiest type to construct. Probably, also, he did not realize that the fat, squat shape was better aerodynamically. It was in 1894, when he was 56 years old, that he commenced to design his first rigid ship. She was ready for flight by 1900, and by 1906 he had achieved what could be described as a really successful rigid airship. Before the War, with a total of six commercial airships, of which three were damaged and written off during the trial period, he carried 37,250 passengers in a total of 1,600 flights over a distance of 90,000 miles, without accident to a single passenger.

The Germans have built considerably over 100 rigid ships, and finally, at the present time, they have recently completed LZ.127, of 3,700,000 cubic feet capacity.

We built nine rigids and 213 non-rigids, and we are now engaged in building two rigid ships, R.100 and R.101, of 5,000,000 cubic feet capacity.

The Americans have put out competitive tenders for designs of two ships of about 6,500,000 cubic feet capacity.

The Italians and Americans and the French have also, in the past, built and operated airships of various types. It will, therefore, be realized that there is a considerable amount of experience available throughout the world, both in regard to the construction and operation of ships, as they have been in serious use for almost 30 years. At the same time, it would be unwise to disguise the fact that there is a great deal still to be learnt, both in regard to construction and operation. The construction of airships, due to the pressure of war, had to proceed faster than scientific investigation. Due to this pressure, it was found to be impossible to devote sufficient time to research into the problems involved, and it is only since the War that this time has become available.

Largely as a result of the accident to R.38, and arising out of the recommendations of the committee who sat to investigate this accident, an extensive programme of research into the problems involved in the design of airships has been conducted in Great Britain during the last few years.

The object of the investigation was to discover the aerodynamic forces acting upon an airship while in flight and at the mooring tower, and to ascertain how and to what extent these forces and the static forces due to loading, set up stresses in the structure. The aerodynamic forces were investigated by means of model tests in the

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wind tunnel and full scale tests in flight in R.33 ; these results were incidentally found to agree closely.

The forces in an airship having been computed, it remained to discover how the primary stresses distributed themselves in the structure. Investigations on a simplified model were carried out to test the value of the theoretical conclusions come to on this subject, and published in a memorandum, *R. and M.* 970, issued by the Aeronautical Research Committee. These investigations generally confirmed the theoretical conclusions, and enabled the Committee of the Airship Panel to lay down factors of safety to which the new airships should be built. Further, to confirm the accuracy of the methods in use, and also to measure the secondary stresses, a complete test bay consisting of two full-size rings connected up by longitudinal girders of R.101 was erected and fully tested for all the stresses they could be put to in flight. The stresses were computed on the results obtained by a number of specially constructed strain-measuring gauges incorporated in the structure. The girders used in the test bay were then tested to destruction singly and in families, to discover the possible variations in strength in any particular girder.

The new ships, during their flight trials, will have incorporated in them a large number of pressure points on the exterior of the hull and also a large number of strain-measuring gauges in the structure, which will enable the stresses, set up by actual aerodynamical pressures in flight during rough weather and all types of manœuvres, to be measured and their incidence compared.

In order to enable this to be done, a governing essential of the present programme has been that the airship hulls should be built too strong rather than perhaps not quite strong enough. It would not be overstating the case to say that the primary object of the programme will have been achieved when these hulls have been successfully constructed, flown, and fully tested.

I will now show you some of the slides of the structure of the two new ships, and point out to you the advantage of the stiff ring for R.101, the system which has been evolved to transmit the lift from the gasbag to the structure for both R.100 and R.101, and how this system does away with the disadvantage of the lateral loading of the girders by the gas lift, and also how it is possible to transmit this gas lift direct to the requisite points in the structure.

Part of the policy of the Government has been to produce, as the result of this programme, two competent airship designing staffs. In order to do this, no detail information in regard to the two designs has been exchanged, but only information fundamental to the design of rigid airships. It is interesting to see the result of this policy in the actual design of the two ships.

Both designers have, as I mentioned before, eliminated the previous

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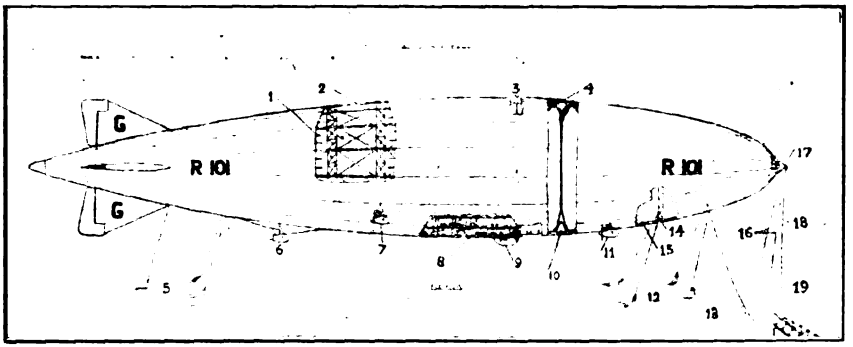
difficulties of transmitting the gas lift to the structure without stressing laterally the girders of the ship.

In addition, in R.100 the effect of the secondary stresses from ring to longitudinal, which occur in the Zeppelin type, have been very much reduced by means of a very ingenious type of joint.

In R.101 this type of joint is not necessary, as the stresses which occur in R.100 are allowed for by the gasbag wire suspension in another way.

In R.100 the passenger accommodation is built up in a separate unit, and slung in one bay of the airship. In R.101 the passenger accommodation has been placed in the lower part of the ship, and actually built into the structure of the ship. At the same time, in both ships arrangements have been made whereby no stress inherent in either structure can be transferred from the ship to the passenger structure or *vice versa*.



1. Reefing boom.
2. Framing exposed.
3. Observation platform.
4. Gasbags exposed.
5 & 12. Handling guys.
6. Power car.
7 & 11. Power car, port and starboard.
8. Passenger accommodation.
9. Control car.
10. Mails and goods space; also at frame 10.
13. Trail rope.
14. Side gangway entrance.
15. Main corridor from bow to passenger accommodation; on port side only.
16. Side guy wires.
17. Bow mooring gear.
18. Main mooring wire.
19. Coupling.

The designer of R.101 has also introduced stainless steel into the structure of the airship, steam heating for the passengers, and a system whereby the airship can have her trim altered by blowing ballast from end to end of the ship by air pressure.

In both R.100 and R.101 allowance has been made for the type of stress which mooring at the mooring tower introduces. These stresses actually are the governing factor in the strength of the ship for the first third of the length of the ship.

As I mentioned before, model tests in the wind channels at N.P.L. were carried out early in the programme. By means of these tests

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the most efficient shape, fins, power bodies, etc., were ascertained. Actually the shapes of the two designs are very similar, but in matters of detail in regard to the shape of the fins, the placing of the power bodies, the control car, etc., the designers have varied a little.

These two ships are the first airships which have ever been built to specified factors of safety, and are probably three or four times as strong as any previous rigid airship built.

The meteorologists, by means of calculation in regard to the size of hailstones, inform us that vertical currents in the centres of thunderstorms with speeds of up to 7,000 feet per minute, occur in very phenomenal storms, but recommend that 4,000 ft. a minute is a safe figure to allow for. Both R.100 and R.101 have, therefore, been built to withstand a rate of rise of 4,000 feet per minute. You will, no doubt, appreciate that this rate of rise and fall introduces rather drastic considerations in regard to the release of gas from the bags and the release and entrance of air from and into the interior of the hull. No good airship captain would ever take his ship into an area where such conditions prevailed, and I have merely given you this as an illustration of the extreme caution of the policy governing the construction of these ships.

A point on which we are not yet clear is as to the rate of change of velocity and rate of change of direction of wind gusts in abnormal conditions.

These variations in the structure of the atmosphere, particularly those which occur close to the ground, are vital factors in the consideration of the strength which should be embodied in the hull of an airship, especially when lying to a mooring tower. A full scale meteorological investigation to ascertain these conditions is now in process at Cardington. Four synchronized anemometer masts, covering the area which would be occupied by a modern airship, have been set up at Cardington to enable such wind structures to be analysed. This investigation is not yet complete, but as far as it has gone, it has tended to show that conditions are not as bad as we had allowed for. The calculations as to the stresses likely to be set up, based on these results, will be confirmed in actual practice when the airship lies at the mooring tower.

Several innovations, other than in the structure, are being introduced into these new airships. For instance, in R.101 it is hoped to fit the engines with a variable-pitch propeller, which will not only enable the pitch to be varied so as to obtain the greatest propeller efficiency for the number of revolutions run, but will also enable the propellers to be used for checking the headway of the airship as she approaches the tower, without reversing the engine. The engines themselves in R.101 are to be heavy oil or Diesel engines. This does away not only with risk of fire from carrying petrol, but also with the complications of magnetos, sparking plugs, etc. The engines

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we are using for R.101 are the first experimental type, and consequently may give trouble. They are also very much heavier than petrol engines, the 650 h.p. engine we are using weighing 4,600 lb. —nearly 8 lb. per h.p. The heavy oil engine will probably always be heavier than the petrol engine of the same h.p., but as it burns a smaller weight of fuel, it is even now superior to the petrol engine for long flights.

The risk of fire with heavy oil fuel is negligible, the flash point of this fuel is 210°, and it will actually put out petrol fires.

The engines in R.101 are steam and not water-cooled engines. The steam of two of the engines is used for heating the passenger accommodation and supplies ample heating for the purpose.

R.100 is to be equipped with Condor engines at first, but it is the intention to re-equip her with heavy oil engines later.

The electric generators are operated by a small auxiliary engine, or alternatively by a windmill which maintains a constant speed whatever the speed of the airship.

Other developments which will be introduced for future ships, but will not be tried out at first, are hydrogen burning in the engine and water recovery. At present, as we burn our fuel as we proceed on a voyage, gas has to be valved and therefore wasted. Water recovery would partly eliminate this waste, and hydrogen burning in combination would completely do so.

The passenger accommodation embodied in both R.100 and R.101, while not up to the standard achieved by the modern liner, is not far short of it in some respects. The largest room, for instance, in R.101 is some 65 feet by 35 feet, while, if the cabin accommodation is on the small side, the beds will be comfortable. Ordinary meals will be supplied, cooked on electric cookers, while all ordinary amenities, including shower baths, are available.

I will now pass from construction to operation, but I have naturally only been able to touch upon the main points, and if anybody wishes to know anything else, I hope they will question me after the lecture.

OPERATION.

There are a great many factors to be considered under this heading. The first and most important is economy of effort.

In the past, airships had to be handled and operated from sheds. This is most uneconomical. At the end of the War, efforts were made to develop the mooring mast, as it was then called, but it was not until 1921 that a system, known as the vertical system of approach, was evolved, by means of which an airship was enabled to approach and moor up to a mooring tower. With the old ship R.33 they proved that airships could moor up in winds of 30 m.p.h., remain at the mooring tower in winds up to 60 m.p.h., and leave the mooring

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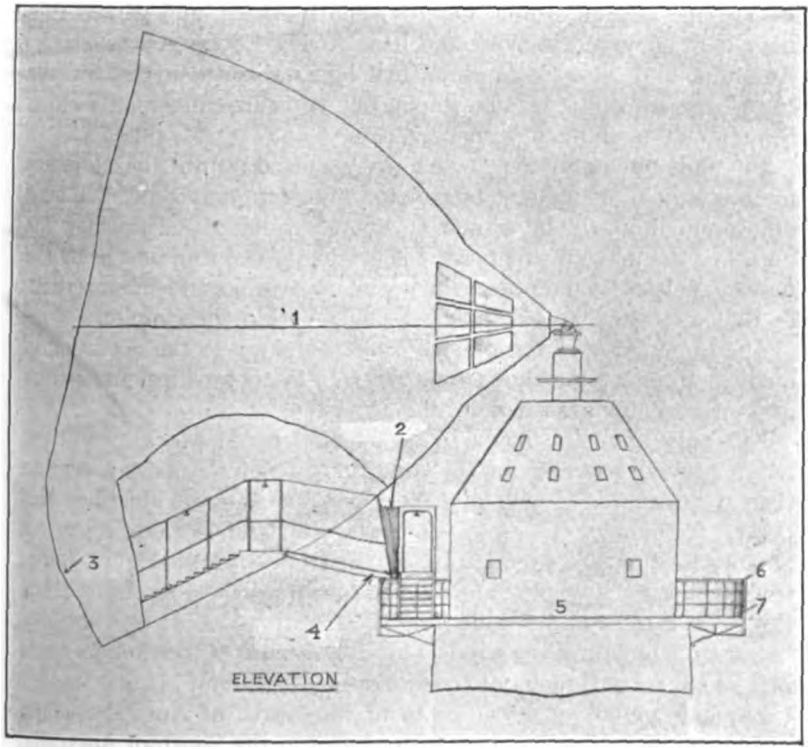
tower in winds of 40 m.p.h. These results will, no doubt, be much improved upon in the future.

I will now explain the mooring tower system to you with lantern slides.

In regard to the handling of airships into airship sheds, you will realize that this is a very difficult and delicate operation with ships of the size of R.101. The lateral or broadside surface of the ship will be something in the order of 70,000 square feet, as compared



1. Axis of ship.
2. Adjustable platform on mast to suit ship.
3. To passenger accommodation amidships.
4. Combined slide and rollers (running round on rail). Taking hinged gangway of ship.
5. Passenger platform.
6. Rail.
7. Metal sheet weather dodger.

Diagram of bow mooring system

with the end-on surface of something like 13,000 square feet, and at the same time this vast object, it must be remembered, although it has a mass of 150 tons, has no weight. That is to say, from the control point of view, it is the equivalent of an enormous feather. Realizing this, you will see the limitations imposed by the winds upon handling airships into sheds. The Germans say they have

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handled ships into and out of sheds in winds up to 25 m.p.h. in a direction nearly parallel to the sheds, when using handling trollies running on rails fixed in the ground; but in Great Britain, by the system we at present use, we would not attempt such a feat, and to handle a ship of that size into a shed, in winds not exceeding 10 miles per hour, takes anything between 400 to 700 men. The advantage of the mooring tower, with its crew of 14 men, therefore becomes very obvious in regard to economy.

In the present programme, mooring tower bases are being erected in England, Egypt, India, Canada, South Africa, and various sites have been surveyed in West and East Africa, Ceylon, Cocos Islands, Australia and New Zealand. Until bases throughout the Empire have been set up, it will be impossible to utilize airships for either commercial or military purposes.

But it is not only bases which are required; until the necessary meteorological arrangements and communication system have been organized, it would be unsafe to operate airships. Therefore, the object of the present programme is gradually to bring into being the necessary bases, communications and meteorological organization, so that airships may be operated safely within the Empire.

The importance of the science of meteorology to the operation of airships it is impossible to exaggerate. With airships, navigation and meteorology are inseparable.

Not only have the bases to be selected for the local conditions which prevail, but also for the conditions which normally prevail in their approaches. I will give you one instance to illustrate this point. Visualizing the map of the world, the obvious route for airships to Australia would appear to be from England–Egypt–India, from thence to Singapore and thence to the North of Australia; but this route is most undesirable from the airship point of view, not only because of the prevailing winds, but also because of the thunderstorm belt which is continuous to the North of Australia.

Similarly, mooring tower bases in the North of Australia would not be as suitable as mooring tower bases in the South of Australia, due to the fact that the area in the North is the hot area. Airships would not only have less lift, but air is more unstable in these areas, and also the cover and bags of airships deteriorate more rapidly in hot climates.

You probably all know that in certain areas of the world seasonal and prevailing winds are normal. They were the winds used by the old sailing captains, and they will be the winds used by the future airship captains.

Take the route from the Cape to Australia; the "roaring forties" or Westerlies will help the airship at a high speed from Capetown to Perth, by keeping south. Equally so, the S.E. Trades will help the airship from Perth to the Cape, by keeping north.

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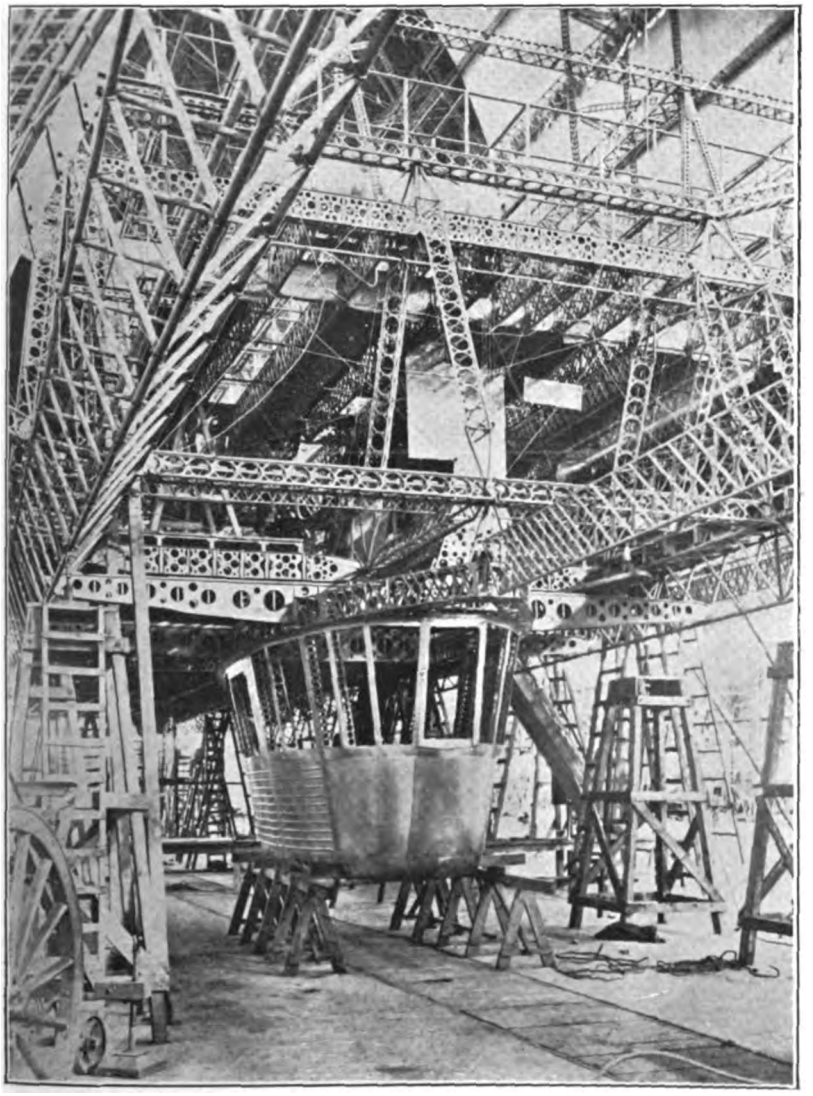
AIRSHIP DEVELOPMENT.



Control car R101.

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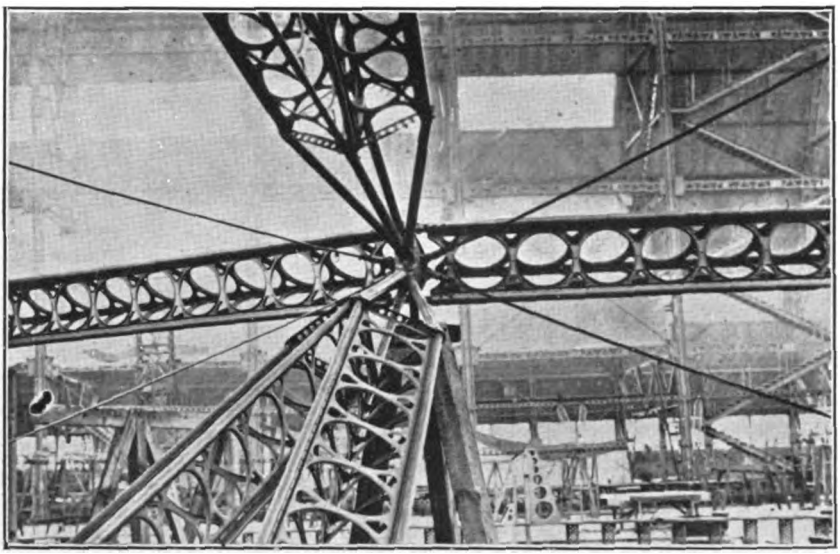
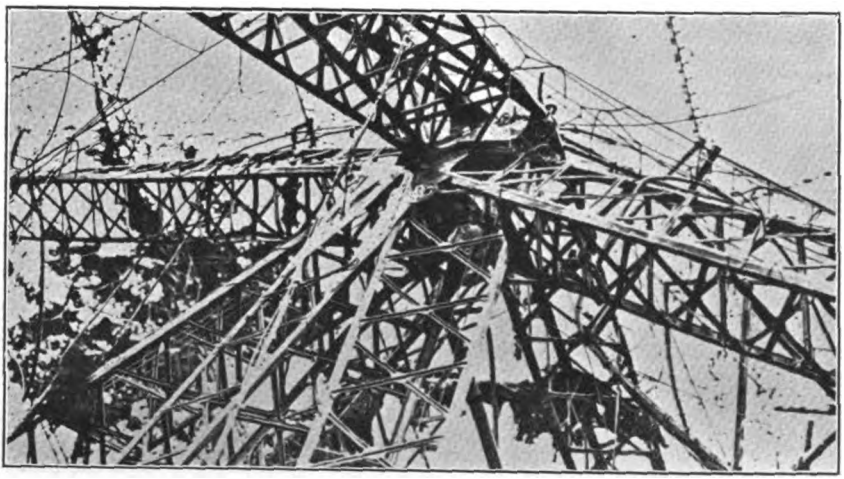
Types of Structure.



R101 type.



Zeppelin type.

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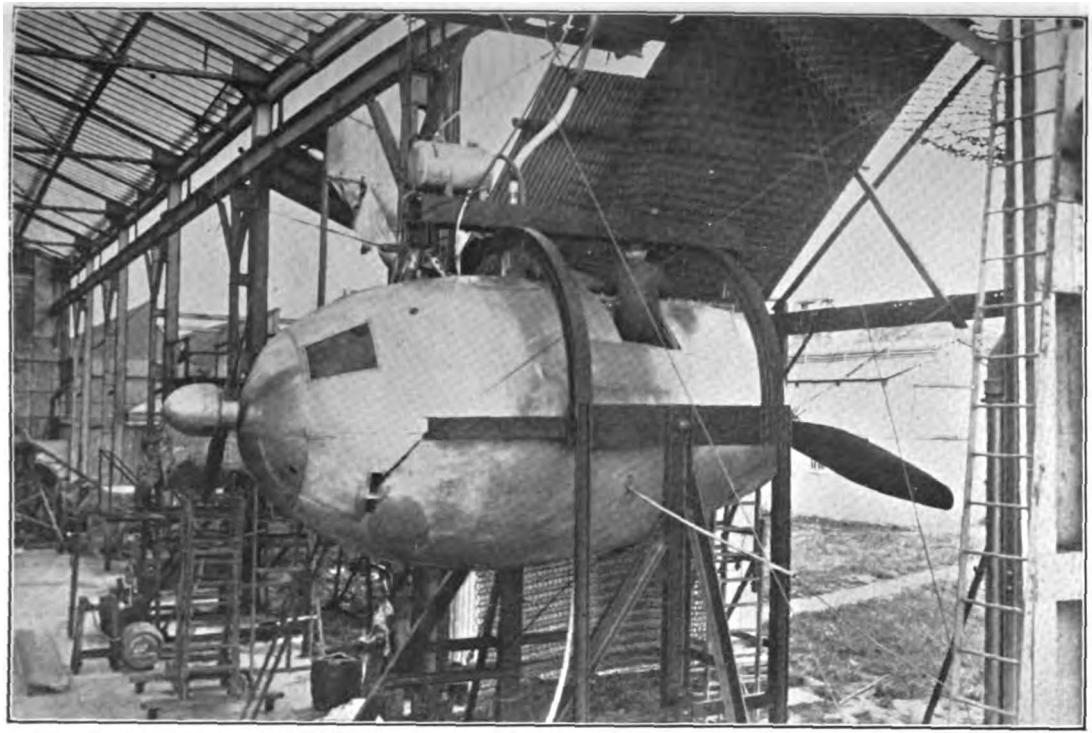

Power body of R101 mounted for gantry tests.

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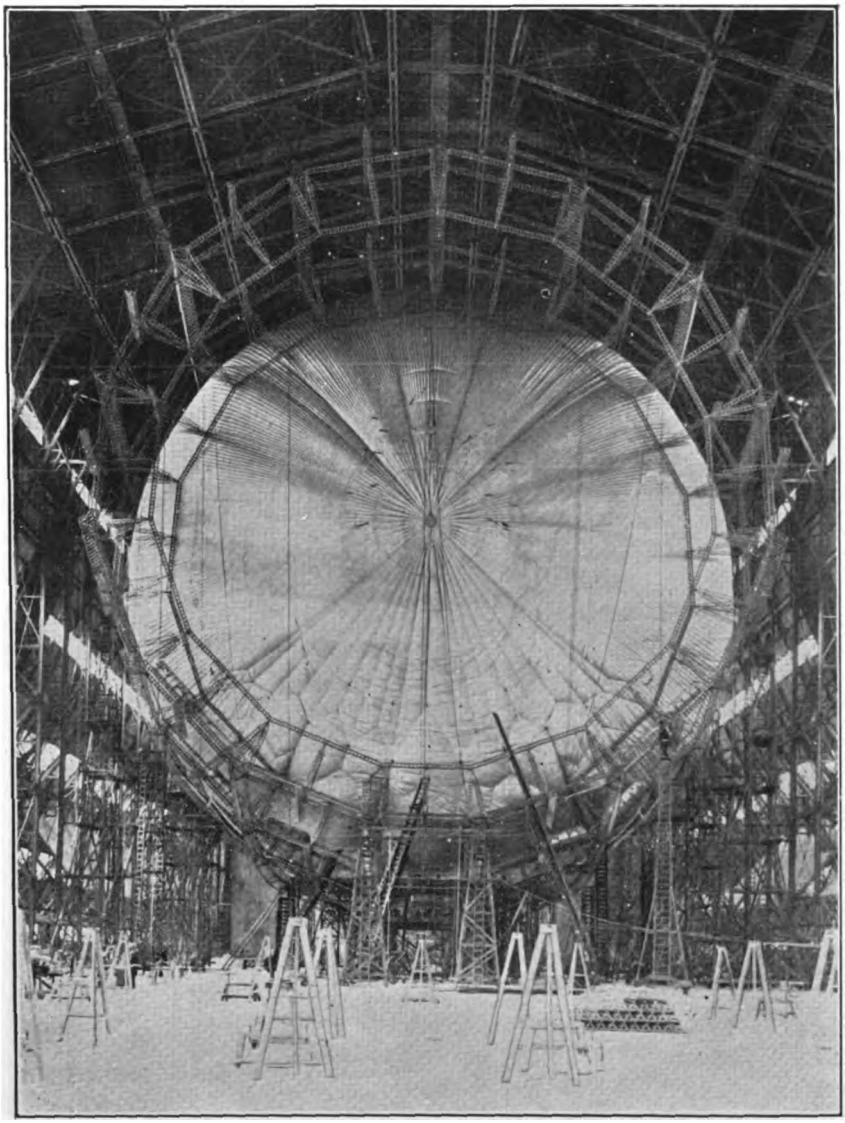

Gas bag inflated in R101 during construction.

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I have mentioned thunderstorms, so I think it would be desirable to explain to you that thunderstorms are not the serious matter to rigid airships that they are generally thought to be, in so far as the actual lightning is concerned. Rigid airships have frequently been struck by lightning in the past, and the only known effect has been partially to fuse the metal of the structure at the point of entry of the flash. The cross-section of the metal of the structure, which forms a continuous Faraday cage around the whole of the ship, is amply large enough safely to convey the amperage transmitted by a discharge. It is generally agreed that these discharges, and also the gradual change of potential due to alteration of height, etc., are conveyed away through the engine exhaust. How dangerous to airships the vertical currents of air which occur high up in thunderstorms and line squalls may be yet remains to be proved, but we believe we have made ample allowance for them in the structure of the ship. The experienced airship captain will avoid these upcurrents by flying low when in the neighbourhood of these conditions, and will thus avoid high speed vertical currents and also the one real danger in a thunderstorm, which is the necessity to valve gas.

Our meteorological branch have been analysing the conditions which have prevailed on the routes on which the airships will first fly, for several years, and the airship staff have been carrying out theoretical exercises in flying an airship with similar speed to R.101 over these routes, utilizing the actual weather conditions which existed in past years; that is to say, in November of this year they will be using conditions in carrying out their exercises, which actually occurred in Novembers of past years. These exercises are not only providing our airship staff with the same type of experience as that which they will gain in actual flight, but are also practically teaching them the weather map of the world in the neighbourhood of the routes over which they will have to fly.

Commercial Considerations.

The first consideration in commerce is, of course, profit; but before profit can be achieved, safety, reliability, and punctuality have to be demonstrated. A very distinguished authority in the commercial world, Sir Alan Anderson, has told us that airships, within limits, can largely disregard expense provided they can ensure these three factors, safety, reliability, and punctuality, because the great increase of speed which airships will be able to bring about in communications is of such vital importance. With the ships we are now building, it is anticipated that Egypt will be within two days, India within 4½ days, Australia within 11 days, and New Zealand within 14 days of Great Britain.

What this means to the world it is impossible to foresee, but that

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it will have a great effect is unquestionable, and it would be an interesting exercise for the imagination to take the existing map of the world's steamship routes, and even railway routes, and endeavour to forecast how much they will be diverted in the future by the effect of not only airship but also aeroplane transport.

There are certain commodities in commercial transport which can afford to pay for fast transport: they are passengers, mails, specie and valuable light freight generally, and it is these very commodities which the airship can conveniently carry.

I was much struck by the point of view of Dominion business men during my recent tour. In their view, the most important service the airships could render the Empire was not that of mail carrying, but that they would enable important business heads to meet personally with considerably greater frequency than they could achieve at present.

The present programme of building two airships is obviously only a very small beginning. These two airships can, at most, obtain certain data for the commercial brains to consider. I very much doubt if two airships will be able to obtain sufficient, because it seems to me that before commercial organizations can spend the money of their subscribers on airship development, they will have to have a very clear line to go upon, both in regard to reliability and expense. If, say, running these two experimental airships over the route between England and India for one year, to a regular but not very frequent time-table, is sufficient to convince the shipping interests that airships are a potentially serious rival, then two airships are probably sufficient; but the mind of the world is very loyal to its old convictions, and I think it will be necessary for airships actually to commence to affect traffic receipts before they will obtain very important business consideration.

Airships are, unfortunately, rather expensive because of their great size, and people are rather apt to think because we have been a long time in producing these airships, that therefore they ought to come out perfect, but naturally this cannot be so any more than is the case with the first of a new type of motor-car.

The expense of their bases I do not think will seriously matter, as it will be so obviously to the interests of the local authorities to erect them that this will not, I think, affect the rate of development of airships. But the expense of the construction and maintenance of the early type of large airship may act as a serious deterrent to commercial organizations at the commencement of their development. This still remains to be seen, but each airship shed, in which to construct a large airship, costs somewhere between £150,000 and £180,000, and there are at present in existence in England only four sheds in which it would be possible to construct a 5,000,000 cubic feet ship, and only two of these are big enough to operate airships from.

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When these two ships commence operations, one of these two sheds will have to be retained as a dock for airships in England. Similarly the shed in India will also have to be retained for such a purpose. It is, therefore, clear that there are only, at most, three sheds available for airship construction at present in the Empire, and in only one of these can a ship be built of over 5,000,000 cubic feet.

So far I have not mentioned the Anglo-Canadian route. This route, due to the weather conditions which prevail between England and Canada, requires a larger airship for its operation than the Eastern route. Our analysis of the weather prevailing led us to believe that a ship to operate this route will have to be of considerably larger size than those now being built. The one shed I have mentioned above would probably be sufficiently large in which to construct such a ship, if some concession in regard to the perfect length/diameter ratio were made.

Surveying the development of airships for commercial purposes in sight at the moment: England is building two definitely for commercial development; the United States have accepted a tender for the construction of two large airships for naval development, but these ships could be used to establish the commercial possibilities of airships; Germany has built one large rigid of nearly 4,000,000 cubic feet, built solely for commercial purposes. Spain and the Argentine have investigated the preparation necessary for the development of commercial airships.

You will see, therefore, that the basis for the commercial development of airships on a large scale is still very meagre. How quickly it will come about really depends, as I have said before, upon the capacity of these first airships to satisfy commercial minds, such as shipowners and bankers, of the desirability of pressing forward quickly with airship development within the British Empire. If they consider that the airship will develop into a serious competitor to the surface ship in regard to passengers, mails, etc., they would be most unwise to allow other nations to catch up on the start we have obtained by embarking on the present airship programme; but, naturally, sober-headed men, such as the heads of our big shipping organizations undoubtedly must be, must have serious proof before they can move, but there can be no doubt that the right people to move, when the moment arrives, must be the big shipping organizations. They have the experience of handling large craft, and they have the office organization throughout the world to deal with the administration, upkeep, etc., of such craft.

A business man suggested to me the other day that airships are now in much the same position in regard to steamships as the wireless companies were to the telegraph companies some years ago. We all know who held the trump cards in the recent negotiations for the

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merging of these two interests, whereas, had the telegraph companies displayed real foresight twenty years ago, they would never have fallen into this unfavourable position.

MILITARY USES.

If we leave weather conditions out of account—they must, of course, always affect the operation of airships as they do surface ships, but I think they, due to our greater knowledge of airship design and to the perfection of our meteorological arrangements, may be largely discounted—the military uses of airships are, in my opinion, all dependent upon the undoubted vulnerability of the airship. In the last war, before aeroplanes were developed, the Zeppelins were utilized successfully for bombing, but now that not only the aeroplanes but ground organizations for locating aeroplanes and airships, listeners, etc., have been developed, in my opinion, the use of airships for bombing areas defended by aircraft is suicidal, and can never produce total effects which work out in favour of the attacker, as his constructional efforts and organization to produce an airship fleet must always be greater than the total disorganization, etc., which he causes to his enemy.

But if it is accepted that airships normally will not be used in areas which are controlled by enemy heavier-than-air aircraft, it by no means eliminates the airship for war purposes.

In any war in which we engage, there must be large areas of the world friendly to ourselves, and at present the oceanic areas cannot be regarded as areas under control by aircraft. Therefore, for a large number of communication and reconnaissance purposes, the airship is still a valuable war auxiliary.

It would not be logical to agree that the airship, because of its vulnerability, could not be used for such purposes, when we at the same time face the fact that the merchant ship, an equally vulnerable craft, is vital to our existence in these islands. Therefore, when airship bases are established throughout the Empire, there is little doubt that the airship will be a most important means of communication in war, for dispatches, staff officers, light stores, aircraft transport, and even troop transport.

With regard to the latter, it may come about in the future that the War Office will make arrangements whereby the stores for the equipment of troops, etc., will be held in outlying bases so that the troops to use them can be transferred quickly by light and fast transport. If this is done, the economy in the defence of the Empire may prove to be of great importance, as it will no longer be necessary to maintain such large peace garrisons abroad.

Airships will not normally be used for purely offensive purposes, but there are certain cases in which they could be so used with great

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effect. They are:—For the control and, if necessary, bombing of merchant ships in war, and for a similar purpose in regard to inhabitants of territories unarmed with aircraft.

The possibilities of an airship as an aircraft carrier, from which aircraft can drop off and hook on again any number of times, has yet to be proved under normal service conditions. The actual manœuvre of hooking on has been successfully achieved in both this country and in America, but the system and apparatus still require considerable development. There is no difficulty whatever in dropping off in an aeroplane. When the airship carrier comes into being it will largely supplement the surface aircraft carrier, over which it has some considerable advantages.

Airships will probably be able to carry half, or perhaps more, of their total dynamic lift in aircraft, when they are used as aircraft carriers. We are not certain yet how much an aircraft will support itself in the air at the normal cruising speed of an airship. When used as an aircraft transport, airships will be able to absorb their full surplus lift in carrying aircraft, and it is conceivable that more aircraft will be able to embark after the airship is in the air.

The difference between the carrying power of an airship carrier and an airship transport is brought about by the fact that the former cannot valve gas because she has to re-embark her aircraft in the air, whereas the latter can valve gas as she finally gets rid of her aircraft on arrival at her destination. The airship carrier after dropping her aircraft, maintains herself below her pressure height, or height at which she would have to valve gas and so lose lift, by using her dynamic lift. That is, she sets her elevators to drive her down.

When the airship carrier and transport has been developed, many uses for such craft will be found both for defensive and offensive purposes for Air Force and naval operations.

It has been suggested that airships will be used as hospital ships. So far as comfort is concerned, there is no reason against this use, but the difficulty of timely recognition under certain weather conditions may prove an insuperable objection.

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THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

(*Continued.*)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART IV.—OCTOBER, 1915—FEBRUARY, 1917.

Battle Honours during the period—"Somme 1916," "*Albert* 1916," "*Bazentin*," "*Pozieres*," "*Flers Courcelette*," "*Morval.*"

THE LOOS SECTOR.

AFTER the battle of Loos the 23rd (Field) Company withdrew from the line for a few days. Several changes took place amongst the officers; Lieut. Cohen joined on October 1st, and 2nd-Lieut. Vanstone on the 2nd (*vice* Mallins, wounded at Loos). On October 3rd, to the great regret of all ranks, "R.B.," who for nearly two years before the War had trained the Company to its high state of efficiency, and who had for fourteen months guided its destinies through the dangers and difficulties of the campaign with the affectionate loyalty of all those who served with him, at last handed over command of the unit on promotion to C.R.E. 1st Division. On the 8th October, 2nd-Lieut. W. H. Potterton joined.

Between the 5th and 13th October, the Company was again in the line near Hulluch, during which tour the Division carried out an abortive attack on Hulluch, in which Salmon was slightly wounded.

After this, a regular system of company reliefs was inaugurated, the 1st Division holding the Loos sector for many months. Field companies spent one month in Divisional reserve in turn, when the programme included hutting, drill, running, and so on, followed by two months in the forward area. Whilst in the forward area, each company had two sections living and working in the forward area and two sections available for work under the C.R.E.: collection of material, rear defences, road-making, and so on. The Company forward billets were mainly Philosophe and Les Brebis, the forward sections living in Calonne or Loos (Sketch 15).

Except for work at Hart's and Harrison's craters, described later, the winter of 1915–16 was comparatively quiet, work was organized on an almost peacetime basis, and a few typical jobs will suffice to give an idea of the sapper's life in a "peace" sector.

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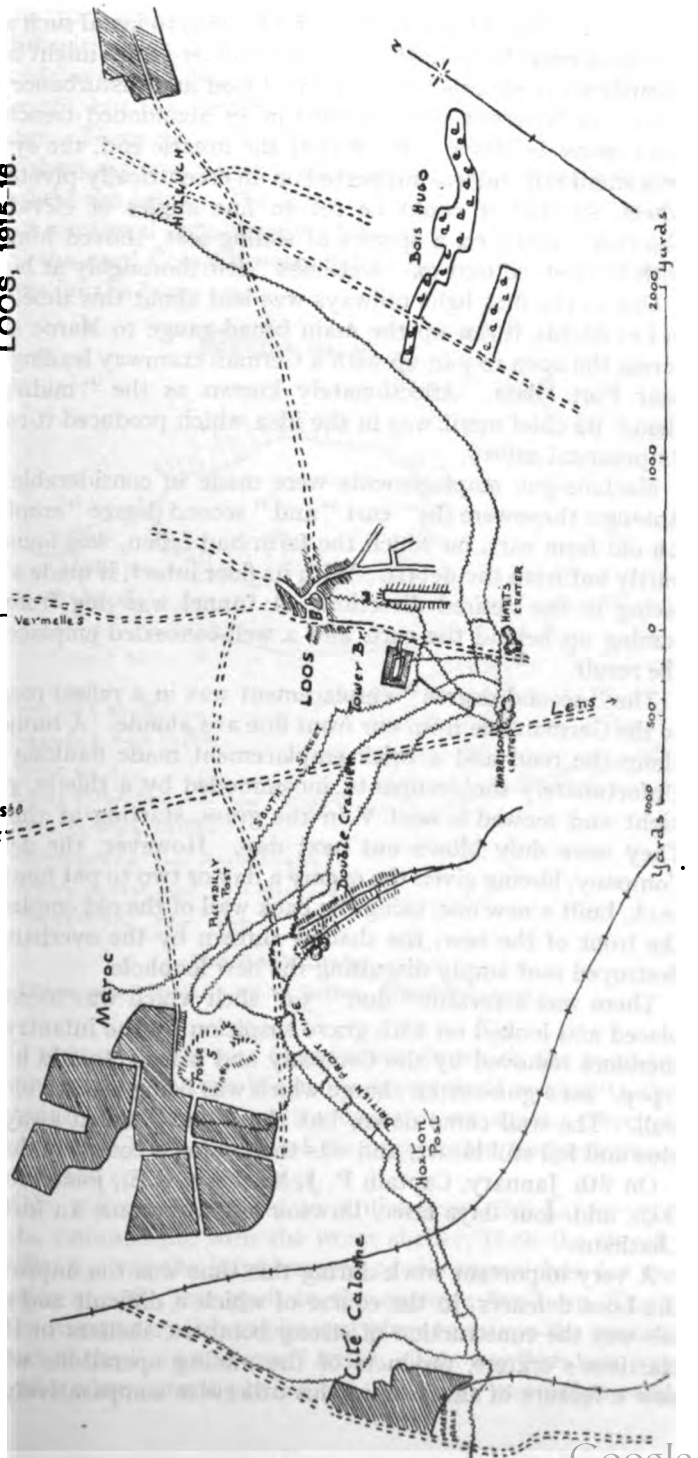
Sketch No. 16.

LOOS, 1915–16.



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A bright thought on the part of " I " was to instal such a powerful telescope near the front that hostile shoulder-straps might be read and identification obtained without the blood and disturbance of a raid. A 15-foot telescope was installed in an abandoned trench north of the Corons de Maroc. Pivoted at the muzzle end, the eyepiece ran on a small rail and was supported on an eccentrically-pivoted grooved wheel, so that it could be set to fine angles of elevation. The observer, seated on a species of sliding-seat, shoved himself about with his feet, so that ex-" wet-bobs " felt thoroughly at home.

One of the first light railways was laid about this time. Starting in Les Brebis, it ran up the main broad-gauge to Maroc and thence across the open to join up with a German tramway leading into Loos near Fort Glatz. Affectionately known as the " midnight choo-choo," its chief merit was in the idea which produced it rather than its practical utility.

Machine-gun emplacements were made in considerable numbers. Amongst these were the " cart " and " second degree " emplacements. An old farm cart, on which the farm had fallen, was found sticking partly out from the debris. With its floor intact, it made a dark hole facing in the desired direction. A tunnel was dug from a cellar, coming up behind the cart, and a well-concealed emplacement was the result.

The " second degree " emplacement was in a raised road running to the German line from our front line at Calonne. A tunnel was cut along the road and a brick emplacement made flanking our wire. Unfortunately the occupants, incommoded by a thistle, got out by night and mowed a neat V in the grass, starting at the loophole. They were duly blown out next day. However, the 23rd (Field) Company, having given the enemy a day or two to pat himself on the back, built a new one, using the back wall of the old emplacement as the front of the new, the shadow thrown by the overhanging half-destroyed roof amply disguising the new loophole.

There was a certain " dud " 5·9" shell which was inconveniently placed and looked on with grave suspicion by the infantry. It was therefore removed by the Company and placed, to add a bit more " pep," on a gun-cotton charge which was being used to blow down a wall. The wall came down, but the " dud " sailed away into the blue and fell still intact, and was then voted a complete dud.

On 8th January, Captain P. J. Mackesy, R.E., joined for duty as O.C., and, four days later, Dawson left to become an instructor at Chatham.

A very important work during this time was the improvement of the Loos defences, in the course of which a difficult and dangerous job was the construction of strong bombers' shelters in Hart's and Harrison's craters, products of the mining operations which were now a feature of the War in this otherwise comparatively peaceful

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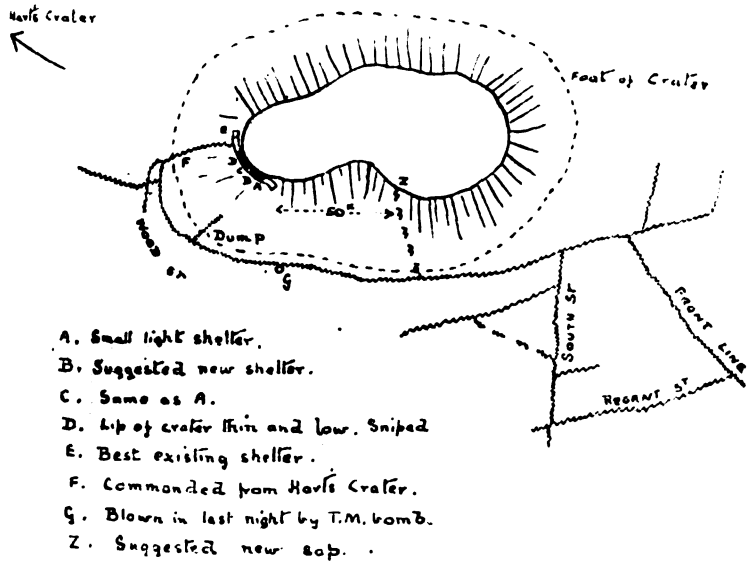
sector. The work was so admirably carried out in the face of considerable difficulties that it is well worth describing in some detail.

The records available deal almost entirely with Harrison's crater (Sketch No. 16), but the conditions there were equally applicable to Hart's crater. These two, lying between the opposing front lines, were but a short distance apart. In each case the enemy held one lip and we held the other. The interest of both parties was maintained by a continual interchange of bombs, and as shelter was inadequate, the 23rd Company was called upon to provide bomb-proof shelters for the home team.

SKETCH No. 16.



Harrison's Crater.

(From report by O.C. No. 2 Section, March 8th, 1916.)

Light and rickety shelter was in existence, in which the bombers led a cramped and precarious life in the intervals of coming to the surface, heaving a bomb, and getting under cover again. Perched on the mound made by the debris of the huge crater, the performers were on an all too conspicuous stage.

Salmon (No. 2 Section) decided to utilize short R.S.J.s for roof and uprights, commencing with the worst shelter, B on the sketch. The first difficulty was the improvement of the approaches, for the communication sap, F, was open to the enemy's fire from Hart's crater, and movement up this unpleasant place to escape the snipers' attention was of the " tip and run " order. This was " no bon," as the soldier said, when carrying half a cwt. of R.S.J., and Salmon and

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his men started a new approach from the other side. Some work had been begun here before, for in the mud of a shallow, battered trench were found the bodies of four men of the 26th Field Company. The enemy looked on this new development with little favour, and on successive nights made the work so unpleasant that it was found necessary to reduce the shifts from three hours to two hours to enable the sappers to bear the strain. Parties of two N.C.O.s and five sappers formed a shift. It was a thoroughly unpleasant corner; the men had to work up to their knees in a chalky, glutinous mud, ever and again waiting a moment in the meagre cover until the "whoo—oo—oo CRASH" and the subsequent pitter-patter of the falling mud and splinters had finished; then they would get going again, with perhaps part of the night's work to be done all over again. At the same time, constant watch had to be kept against crawling enemy bombers amongst the heaped-up debris of the crater. However, the approach sap was eventually completed and an infantry party of an officer and 20 men (nominally "resting" after a spell in the line) was provided to carry up the R.S.J.s. Unfortunately, at the critical moment when, stumbling and heaving along the muddy trench, they were about to dump their burdens at the foot of the crater, the enemy started to interfere, and it was not until next night that Salmon and his stalwarts were able to salve eight or twelve of the precious joists from the debris of the battered trench. Nevertheless the sappers stuck to their work with indomitable spirit, and in spite of constant shell-fire, sniping, and trench-mortar bombs, the work was completed.

Potterton, at Hart's crater, was faced with a similar situation, but having, after a week's hard work, completed his shelter, he had the heartbreaking experience of seeing it scattered by a T.M. bomb, and had to start again. The spirit in which the work was done cannot be better exemplified than in the words of the Divisional Commander:

To C.R.E. 1st Division.

I have noted with great pleasure the good work done by Nos. 1 and 2 Sections of the 23rd (Field) Company, R.E., on Hart's and Harrison's craters, and the soldierly spirit which induced these two sections to volunteer to continue the work rather than be relieved, so as to avoid the waste of time involved in carrying out such relief.

Special credit is due to the two officers commanding the above sections, viz., Lieuts. Potterton and Salmon.

A. HOLLAND, *Major-General*,
20.3.16. Comdg. 1st Division.

At this time, a system was inaugurated of attaching infantry officers to the Field Companies for instructional purposes, so

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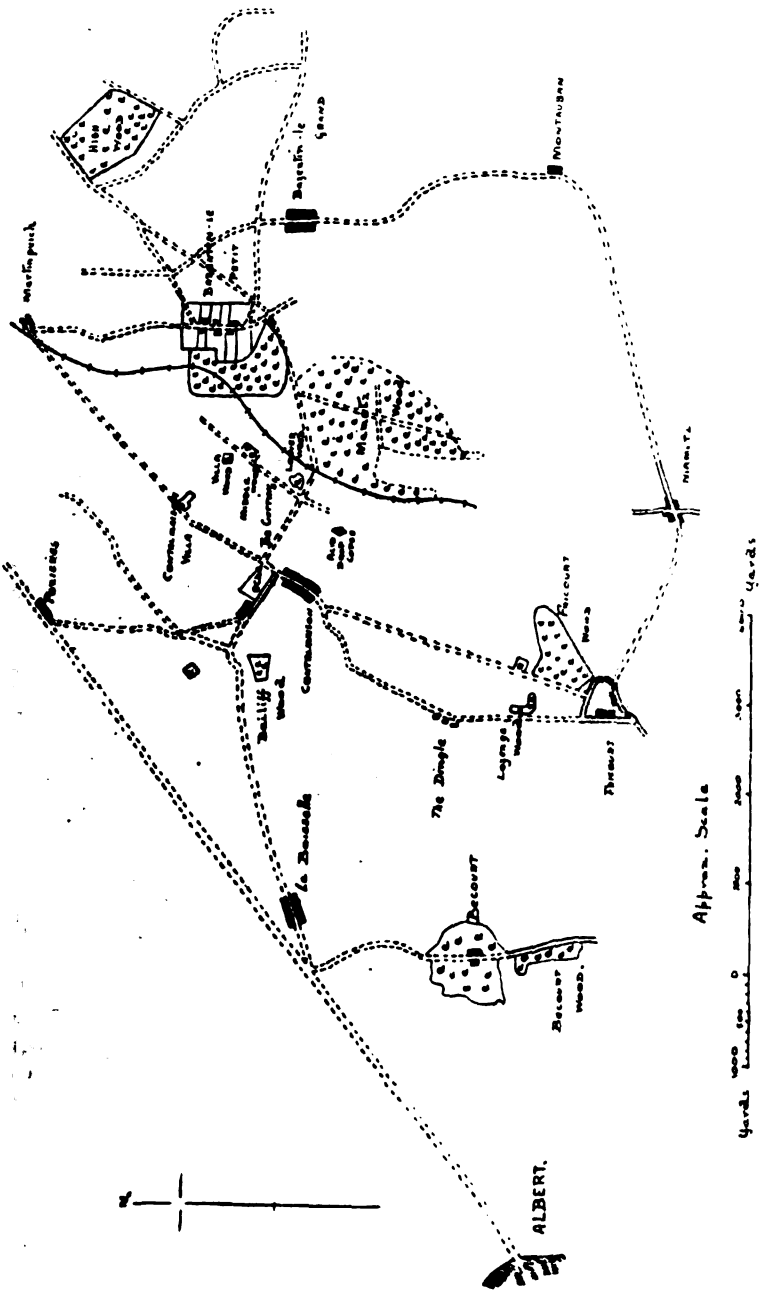
Sketch No. 17.

THE SOMME.

1st Division Operations, 1916.



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that these officers might return to their units trained in pioneer duties.

On 3rd June, 1916, Wilson, now promoted Captain as Second-in-command, was awarded the Military Cross, and C.S.M. Hudson, who had carried out his responsible duties in an admirable manner from the first days of the War, was awarded the D.C.M.

In Appendix D is shown a typical day's work extracted from the 23rd (Field) Company's progress report.

THE BATTLE OF THE SOMME (Sketches 17 and 18).

The Battle of the Somme commenced on July 1st, 1916, and it was not long before the 1st Division was drawn into the maelstrom, for on July 4th the Company moved at short notice to Ruitz, entrained at Fouquereuil at 2.15 a.m. on July 7th, and detrained at Doullens at 7.15 a.m. Marching on the 7th and following days by Warnies—Naours—Molliens aux Bois, the unit joined the 1st Infantry Brigade at Baisieux at 11.45 a.m. on the 9th. On the 12th, the increasing roar of hundreds of guns in action, swelling in a volume of sound beyond anything that the 23rd had yet experienced, formed the accompaniment to the march into Albert, where billets were taken over from the 228th (Field) Company (19th Division).

The 1st Division had just taken over the Contalmaison front after the attack in which the 23rd Division had captured that village. The 1st Infantry Brigade was established from the N.W. corner of Bailiff Wood through the château grounds and along the south-east side of the village nearly to Acid Drop Copse, where the Brigade was in touch with the 21st Division.

All four sections, under Captain Wilson, were ordered up to wire the front line and the keep at Contalmaison, where the 2nd and 3rd Infantry Brigades were taking over from the 1st. The front line at this time was as shown on the sketch. Contalmaison had crumbled into ruin under our bombardment, the road was practically obliterated. Immense holes, loose coils and shattered strands of barbed wire, piles of brick and rubble that had once been houses, uprooted trees, and all the mangled debris of the shell storm made unrecognizable the face of the landscape. But for the moment the artillery-fire had more or less died down, though on the move forward Salmon had a narrow escape. A shell bursting near him, a considerable lump of metal hit his saddle, where it was subsequently found driven right up the burr without having touched either himself or his horse, "Black Bess." Needless to say, his rude brother officers pointed out that this would not have been possible had his knee grip been all that one could wish.

The wire for this operation had to be "humped" from a dump somewhere about Lozenge Wood, and for this purpose the infantry

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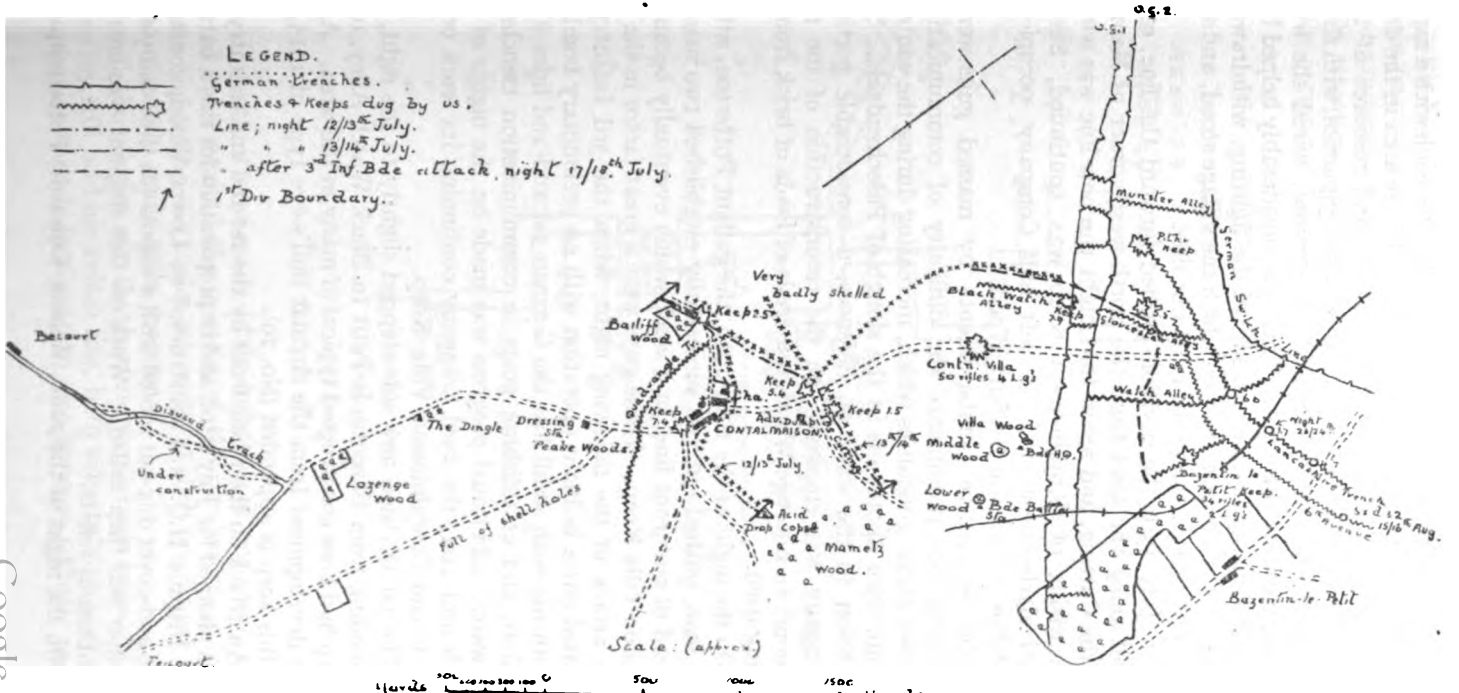
CONTALMAISON.

Sketch No. 18.

July, 1916.



(Adapted from Sketch in 23rd Fd. Coy War Diary).

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were divided into parties of about a platoon, each with a sapper guide. The task of the guides in the tumbled battle area in the dark was no easy one, but as usual the initiative and resource of the sapper carried him through, and the large infantry parties, with the guidance and assistance of Wilson and his sections, wired the whole front strongly during the night. This was considerably helped by the fact that the enemy had, as a result of the fighting, withdrawn over the crest of the convex spur on which the village stood, and apparently was not sure of the position of our line.

On July 13th, the division pushed forward the line, establishing itself along the road from the north-west corner of Mametz Wood to the Cutting, and again that night the new line was wired, whilst the wiring of Contalmaison Keep was continued, Smith doing particularly fine work. The left half Company occupied uncomfortable bivouacs in Becourt Wood.

The destructive bombardments by massed guns were already bringing into prominence the difficulty of communication in the shelled areas, difficulties which, increasing during the winter, were to attain their apotheosis in the slough of Passchendaele. So that, in addition to the work on defences, a considerable portion of the Company was employed on the reconstruction of the road from Becourt to Lozenge Wood, hundreds of loads of brick from Fricourt being used.

On the night of the 16th–17th, the gallant Potterton, with some of his men, pushed out and successfully established two machine-guns ahead of our front line, in a work which eventually became Contalmaison Villa Keep. These guns were a great factor in the success of the attack of the following night, when the 3rd Infantry Brigade carried out a brilliant operation with no preliminary bombardment, capturing with small loss the German 1st and 2nd lines (O.G.1 and O.G.2), and establishing posts in communication trenches further forward; additional progress was made on the nights of the 19th, 20th and 21st, the 23rd Company continuing its work on forward roads and Contalmaison Villa Keep.

The 1st Division now side-stepped slightly to the right, the front extending from Bazentin-le-Petit to Black Watch Alley, in which a keep had been constructed typical of many in this area. As it shows the development from the circular bull's-eye type of 1915, a sketch of this keep is appended (No. 19).

An attack on the whole front by the 1st and 2nd Infantry Brigades was planned for July 23rd, and in preparation for this a battle station for Brigade H.Q. was constructed in Lower Wood, consisting of a cut-and-cover dug-out roofed with a cupola (as the "baby elephant" shelter was then called). Work on this dug-out was carried on in continuous reliefs.

On the night of the 22nd, Wilson, Edwards, Potterton, Vanstone

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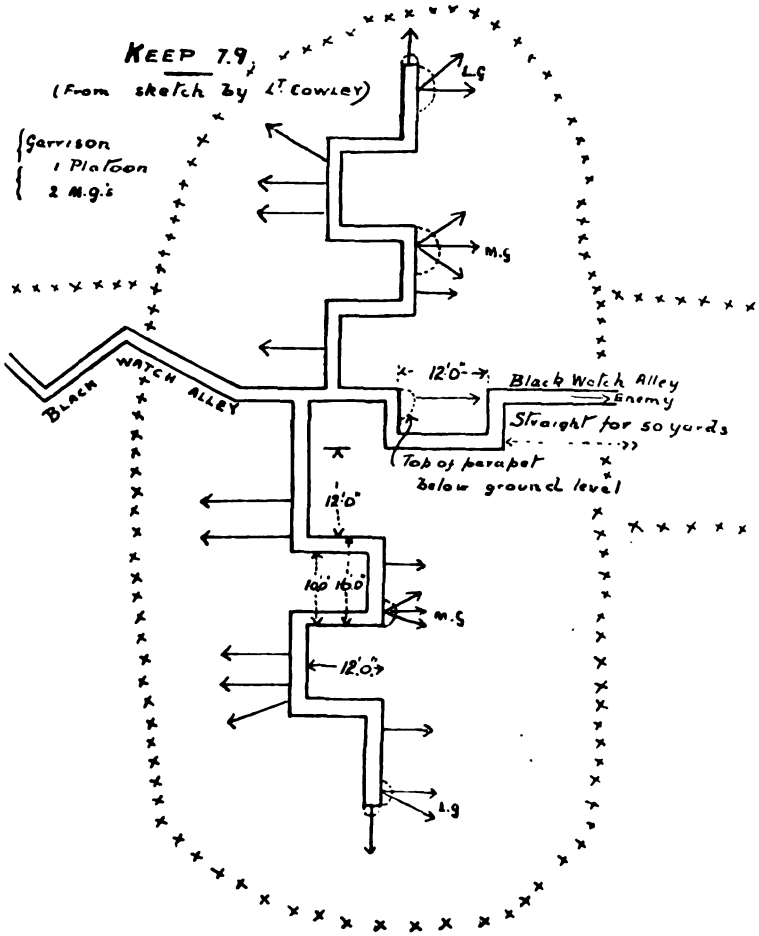
and Smith, with Nos. 1, 3 and 4 Sections, moved up into a position of readiness in Quadrangle Trench, anything but a salubrious residence. A somewhat prominent mark for the enemy's guns, it had received considerable attention; battered and worn and filled with debris, as one of the occupants has said, " nobody but a sapper would look

SKETCH No. 19.



at it "! However, it was made fairly habitable if not ideal, and there the sections awaited the opening of the bombardment, and spent a long and trying day under intermittent shell-fire, whilst the attack unfortunately made little progress.

At nightfall, the position was that we held the German support line and the enemy still held his switch line, both sides holding portions of communication trench between the two as saps. Under these

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conditions the life of the sapper moving about in the dark between the lines was an exciting form of hide and seek. Scrambling round a large shell-hole it was quite easy to go only a quarter of the way round instead of half, and so start off in the wrong direction, whilst Very lights apparently going up in a complete circle gave no assistance as to the direction of the respective lines. It can be imagined, therefore, that when, after this attack, orders were issued for a new line to be dug by the 23rd (Field) Company and a large infantry working party, to cross the T of our communication trench posts between the opposing front lines, it was obvious to every sapper that the work was likely to be one of great delicacy. It was thought at headquarters that the new line was some 200 yards from the enemy's line, but unfortunately this was not the case ; it was subsequently ascertained that the true distance was 110 yards. The enemy in their saphead were closer still, and the working party had barely commenced its task when an unappreciated firework display began, the enemy's Very lights falling behind the infantry and sappers, who were thus silhouetted against the lighted background. Severe casualties were caused, including Potterton killed and Vanstone severely wounded. The former was actually engaged in his favourite amusement of establishing machine-guns in a forward shell-hole. In "Paddy" Potterton the Company lost a very gallant officer, who was quite fearless and had a high reputation for getting his job done whatever were the conditions.

In spite of this set-back, Division H.Q. gave instructions for another try to be made the following night, and in order to secure the digging party against interference Edwards was ordered to go out with two or three sappers and "fortify" a large shell-hole to the flank of the proposed trench, to act as a listening post. The little band, crawling through the long grass, eventually located the correct shell-hole, and had commenced to fortify it when the division next door started a small war, which at once woke up all the neighbours on both sides. Edwards and his worthies were about the M.P.I. of the opposing barrages, the usual sapper situation, so that there was little to choose between the two sides of the hole. When shortly before dawn the racket showed no signs of abating, Edwards decided that rather than spend a day in this open spot it would be better to make a dash for it. Squirming on their tummies through the grass for some distance, they got up and ran for it, and were lucky enough to get in without any harm. This is mentioned as typical of front line jobs in which the Company was continually employed at this time.

On the 26th July, the Company withdrew to Albert to rest, remaining out of the line until August 15th. On August 8th, Parkes, who had gone out with the Company in 1914 and had been wounded in 1915, rejoined ; the sections were now commanded by Edwards

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(No. 1), Salmon (No. 2), Smith (No. 3) and Parkes (No. 4), Cohen being in charge of the transport.

On August 15th, the Company again moved into the forward area, with billets at Fricourt, the 1st Division having taken over a portion of line rather more to the right than before. That night an attempt by a large sapper and infantry working party to dig a new line between Bazentin and High Wood was only partially successful, severe shelling causing heavy casualties to both R.E. and infantry. An attack was planned for the 18th, in connection with which work in continuous reliefs was carried out in the construction of a Brigade H.Q. in Mametz Wood, again a "cut and cover" dug-out with "cupolas," with a bursting course of trees cut and carted from Bazentin-le-Petit Wood. This attack, however, made no progress, and the work of the Company subsequently consisted in the maintenance of tramways, water supply, road construction and so on about Mametz Wood. Work on roads in view of the battered nature of the area was of great importance, and necessitated much carting of timber and bricks, each section using as many as 40 wagons a day. One portion of road about Mametz Wood had been so heavily knocked about that Wilson decided to use slab timber for reconstruction. He was severely taken to task for his wasteful method, rather amusing when one recalls the miles of slab roads at Passchendaele the following year.

High Wood, September 3rd, 1916.

On August 27th and 28th, the 1st Division having now extended its right to take in High Wood, work in Bazentin-le-Grand was taken over from the 11th (Field) Company, 33rd Division, and work was commenced on Brigade H.Q. battle stations and the collection of tools and materials for special operations; as usual in these cases, work was by continuous reliefs, finishing on September 1st.

After a day or two in rest, the operation was carried out at High Wood on the 3rd September. The general plan was for the Black Watch to attack the German line east of High Wood and the Camerons to attack on the west. One officer and 40 men of the Black Watch, assisted by No. 1 Section, 23rd (Field) Company, to establish a machine-gun nest of four guns 50 yards beyond a mine crater to be blown at the south-east cover of High Wood (Sketch No. 20). No. 1 Section was to consolidate the crater.

The mine was exploded at 12.0 noon, and the first sapper party, Cpl. Coles and four or five sappers, at once moved out after the assaulting infantry. Cpl. Coles and several sappers had been more or less seriously hurt by falling debris, as also had been some of Edwards' party waiting in the front line trench. Coles, however, got his small party digging at once, occupying the crater within five minutes of zero, but was almost immediately hit in the shoulder. This wound was bandaged, and he continued directing the work and

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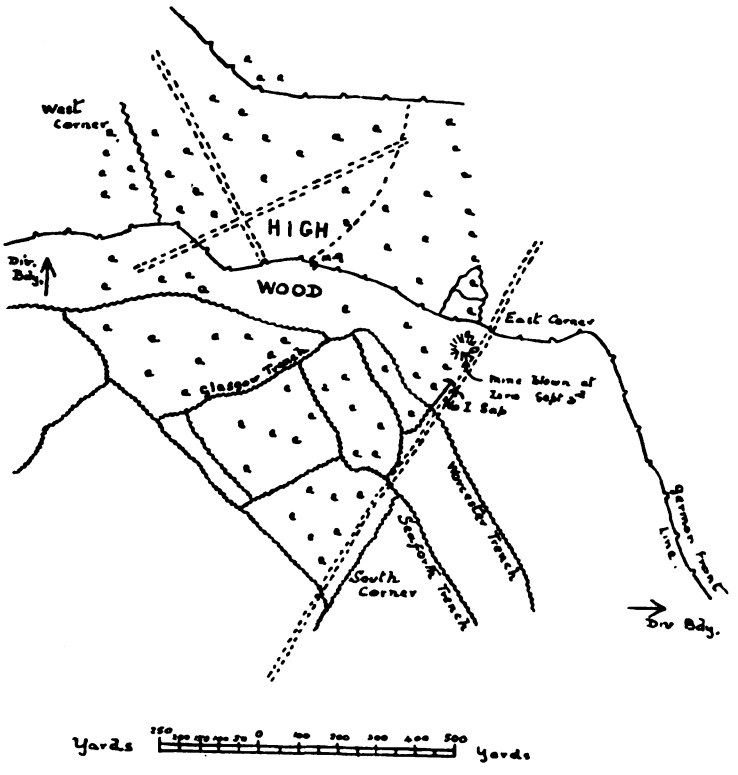
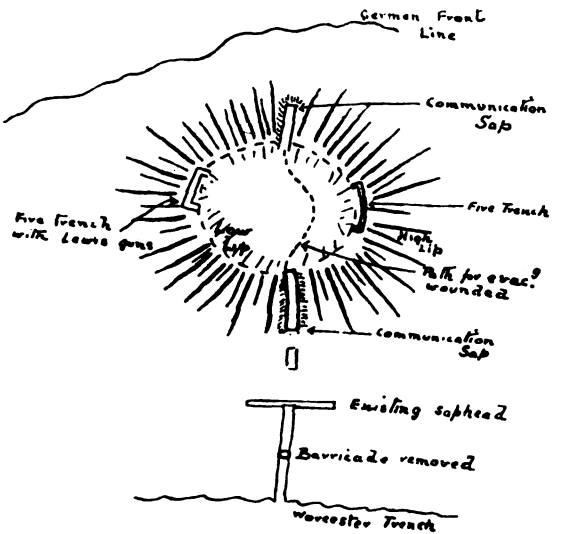
OPERATION AT HIGH WOOD.

Sketch No. 20.

September 3rd, 1916.





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filling sandbags until shot in the jaw, which necessitated his withdrawal to the dressing station. Meanwhile, the work of consolidation was going on well. The Black Watch had captured a portion of the front line and were digging in their machine-guns 50 yards ahead of the crater, whilst Edwards and his section were hard at it running out a communication sap to join up with them and another behind to join up with a sap previously dug forward from our front line. Firing positions were being constructed on the right and left lips of the crater. Unfortunately the left lip being lower than the right, several casualties from machine-gun and rifle-fire coming from the left were caused to sappers working on the right.

About 3.30 p.m., the enemy were seen to be delivering a strong counter attack from half left across the front of the crater party, following the Camerons to the west. The infantry machine-gun nest had been knocked out, and the infantry who had manned the crater trenches were mostly killed or wounded. Edwards, therefore, collected the remains of his section and manned the crater lip, opening fire at short range on the massed enemy. Good practice was made for about 20 minutes, in fact Serjeant Mitchell, who had shown splendid energy in organizing the work and then the defence of the crater, was heard to say it was the best shooting he had ever had. Unhappily, this fine N.C.O. and Corporal Parker were both shot in the head and killed, and two sappers severely wounded. The latter could not be moved, and as Edwards was now running short of ammunition he ordered the remains of his section (only about eight men) to withdraw. The Black Watch in this part of the line had lost all their officers, and Edwards therefore collected such infantry as he could, and his own men, and getting a Lewis gun into action, continued the defence of the front line, inflicting heavy casualties on the enemy until the arrival of infantry reinforcements from the reserve companies. The losses of No. 1 Section amounted to 50% of the strength, but Edwards and his men had splendidly maintained the fighting record of the unit.

The following personal note was received from the 1st Brigade Commander in forwarding a special order complimenting the troops on their gallantry:

"Dear Wilson,

The enclosed order includes your people, and I take the opportunity to express my gratitude for the good work done by your Company, especially the crater party under Lieut. Edwards, and for his valuable information. The 23rd Company has always been most willing to help us in every way, and we couldn't have a better one.

Yours,

6.9.16. A. J. REDDIE."

For their gallant conduct on this occasion Lieut. Edwards received the Military Cross and Lce.-Cpl. Coles a bar to his Military Medal,

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won but a few days earlier for conspicuous gallantry in rescuing a wounded officer.

On the following night, 3rd–4th September, all sections were employed in the repair of our front line trenches damaged by the enemy's defensive barrage.

Subsequent to this operation, the 1st Division and 47th Division relieved one another in the line from time to time, and several valuable advances were made and the line pushed northwards beyond Martinpuich and Flers. The 23rd Company worked as usual on forward defences and roads, dug-outs and salvage of material from old German trenches, on Corps line defences, dressing stations, and so on. It is interesting to note that for the first time in the Company diary mention is now made of a Corps line and army defences, the result of the lessons of defence in depth which the German resistance had shown to be so efficacious. The Corps defences for which the 23rd Company was responsible took the shape of a series of machine-gun nests, pairs of emplacements connected by slit trenches, and provided with dug-outs for the crews.

In the rear areas the main work consisted of roads and hutting, the latter being a very big work. The weather was abominable, and the mud increased daily, so that the strain on the horses, which were continually at work, was very serious, and in spite of unremitting effort on the part of Serjeant Ives, an invaluable mounted section serjeant, when the time came to leave the area the poor old hairies were sadly thin and out of condition.

In October and November, several changes in personnel took place. On 3rd October, Captain Mackesy was evacuated to England, sick, and Captain W. R. Wilson assumed command and was promoted to Major on 11th December; Cohen being promoted to Captain. Salmon (to Asst. Adjt., 1st D.E.) and Parkes (to 6th Pontoon Park) left, and 2nd-Lieuts. P. L. Forwood, Cowley and Gillespie joined, so that the sections were now commanded by Gillespie (No. 1), Cowley (No. 2), Smith (No. 3), and Forwood (No. 4). Cowley was a fine young officer, promoted from the regular ranks of the Corps, and quite fearless, as will be seen later in the story.

The Division remained in the High Wood area until January 25th, 1917. Before leaving, a beautiful cross made of oak from the ruined Bazentin church was constructed by the 23rd Company wheeler and carpenters, and was erected at High Wood in memory of the officers, N.C.O.s and men of the Division. In the summer of 1927, on the erection of the permanent memorial to the 1st Division near Etreux, the High Wood cross was brought home, and, after minor repairs, was re-erected by the 23rd (Field) Company outside 1st Division Headquarters, Aldershot, where, in the presence of representatives of the old Division, it was handed over by Sir Peter Strickland to the care of the G.O.C. 1st Division.

The seven months of ceaseless fighting and struggle against mud

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and destruction had resulted in a casualty list for the Division exceeding 20,000, and the 23rd Company had borne its full share of the fighting and hardships, experiencing 42 battle casualties, representing practically 30 % of the effective strength of the four sections on whom fell the brunt of the losses. The Company had every reason to be proud of its record during these months. It was ere long to show that the mudlarking of the winter had not reduced its powers to execute rapidly and efficiently the more intricate technical jobs which, consequent on the German withdrawal, were to form a welcome change of employment.

APPENDIX D.

23RD (FIELD) COMPANY, R.E.

WORKS REPORT—Mid-day, May 29th, to mid-day, May 30th, 1916.

Calonne Sector.

1. Hoxton Road and Tamworth trench improvements continued; new traverses; revetting.
2. O.P. in York Street continued.
3. Revetting front line near Pit Prop Corner and building new fire bays.
4. O.H.C. to fire bays in Boyau 10.
5. Work on front line continued.
6. Work on reserve line continued.
7. Repairs to water pipe line.
8. Ampthill tunnel, ventilation shaft roofed.
9. M.G. emplacements Ousel's Post continued.
10. M.G.E. at end of Boyau 10 continued.
11. Gas blankets being fitted to cellars.
12. Ampthill tunnel driven 51 ft.
13. Dug-outs: (*a*) Tamworth Trench, right chamber started, left 3 ft.
    (*b*) Deviation Trench, right chamber started, left 2 ft. 6 in.
    (*c*) Hoxton Road No. 1, right chamber 2 ft. left 3 ft.
    Hoxton Road No. 4, right chamber 2 ft. left 4 ft.
14. Road tunnel Calonne Nord to Sud, 90 % complete.

Back Line Work.

1. Protection of Pump Fosse 11. Infantry party filling sandbags and sappers wattling.
2. Trench notice boards being painted.
3. Pipe lines being repaired.
4. Fixing taps to and repairing water tanks.
5. Cutting pit props, trench frames, etc.
6. Loading and carting stores.

(*To be continued*).

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THE ARMOURED FORCE.

A Lecture delivered at the S.M.E., Chatham, on 1st November, 1928, by BRIGADIER R. J. COLLINS, C.M.G., D.S.O., *p.s.c., Brigade Commander, 7th Infantry Brigade.*

IN the limited time at the disposal of a lecturer, I propose to-night to deal only with one aspect of the many-sided problem which we have come to speak of as mechanization. I shall exclude all reference to that side which deals purely with the transportation of troops by mechanical transport, such as was developed to such a vast extent in the Great War—by the French, for example, during the German attacks on Verdun—and shall confine myself to the consideration of wholly mechanized forces capable of operating independently. Of these the present Experimental Armoured Force, which I have the honour to command, was last year the sole example. Now the American Army have also instituted something of a similar nature.

The knowledge of my audience varies probably from a fairly intimate acquaintance with the problem in all its aspects, theoretical as well as practical, to perhaps ignorance not only of the composition and organization of the Armoured Force as it exists to-day, but also of the types of armoured and other vehicles with which we are carrying out the experiment.

I am, therefore, in some difficulty as to how to approach my subject, but have finally decided that I may best hope to meet the wishes of the majority if I endeavour to summarize the result of some two years' experience, to take stock, in fact, of the situation as I see it to-day. You will then, I hope, be able to form your own conclusions. At any rate, those of you who are interested in the experiment—and no professional soldier can, I maintain, remain indifferent—will have a fairly sure jumping-off ground for further study.

I will endeavour to tell you what facts are, I believe, proved, what I personally have learnt, and the conclusions that I have come to.

1. Generally speaking, at the outset, I think it is right to say that armoured forces have shown themselves subject to the same "teething" troubles and limitations—relatively speaking—as normal formations. The human factor plays, in fact, as big a part as ever, and to attempt to ignore it will, as always, be likely only to lead to trouble.

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2. I consider that we may fairly make the following claims for such armoured forces :—

(*a*) That they can function on their own over most types of continental country, but not in mountains, swamps, or forests.
(*b*) That their mobility is already at least double that of normal infantry formations, and is likely to increase yearly.
(*c*) That their power of endurance is far greater.
(*d*) That they have a great moral effect on such normal formations.
(*e*) That they can so limit the latter's freedom of movement as almost to render them immobile.
(*f*) That they are less vulnerable to air attack.
(*g*) That they are almost proof to persistent gas attack.

3. On the other hand, it is also only fair to say that practical experience has shown that they possess the following weaknesses or drawbacks :—

(*a*) They are very expensive in initial cost, though probably less than normal formations in annual upkeep.
(*b*) For their efficient functioning they demand such a high standard of training as to put them beyond the reach of any but a long-service professional army.
(*c*) Their mobility is limited, firstly by the present medium tank, and secondly by the problem of providing protection on the move, which latter is to some extent dependent on the degree and extent to which they can be armoured.
(*d*) They are peculiarly sensitive to ground, more so possibly than was thought until the recent practical tests.
(*e*) All the functions of the horse cannot yet be carried out as efficiently by machines.
(*f*) Their armouring presents a prodigious problem.
(*g*) Since the stationary gun will always have the advantage over the moving one, improvements in artillery and heavy machine-guns are likely to make attack by armoured fighting vehicles increasingly dangerous.
(*h*) Although they are generally economical in men, yet some infantry will always be a necessary part of their organization.

[The lecturer then discussed, with reference to lantern slides, the present state of design and the trend of developments in the case of armoured cars, light scout cars, light and medium tanks, half-track and six-wheel vehicles, self-propelled artillery and heavy machine-guns.]

4. In no walk in life is the attempt to peep into the future more fraught with danger than in the development of Armoured Forces. It is hard sometimes to realize in what an embryonic state these are to-day. But—in so far as our painfully inadequate experience can

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be relied upon—the development along the following lines would appear advisable :—

(*a*) Armoured cars are tending to get so large, so heavy, and so expensive that they must be preceded in reconnaissance by some type of scout, to which the armoured cars will act more as a parent vehicle. For this new *rôle* the light car appears suitable.

(*b*) The medium tank is so wide, so cumbersome and so expensive, as well as so unreliable when called upon to cover long distances on macadam roads, that something cheaper and less cumbersome, even if less powerful, would appear necessary.

(*c*) For all-round simplicity, cheapness, reliability and mobility, six-wheel vehicles should be standard for all types except armoured fighting vehicles.

(*d*) In view of the danger to armoured forces from improvements in anti-tank defence, fast armoured close-support artillery and smoke producers must form a part of such forces.

5. The administrative questions connected with their handling are as numerous and as interesting as any of those so far mentioned. I have time only to touch on one, that of repair and salvage. In asking you to picture to yourselves what the mechanical counterpart of the R.A.V.C. should be, its organization and functions in peace and war, you will quickly get an idea of the immensity of the problem represented by mechanization.

6. Finally, I would urge caution on all those who are called upon to play a part in the development of mechanization. A balanced and considered opinion is not easy to come by. So much that appears in the Press, or even in military journals, is so obviously misinformed. For little reason that one can see, military opinion swings too quickly first to one side and then to the other. Personal predilections and idiosyncrasies, as well as a natural loyalty to the arm of the service in which one has been brought up, all play their part. The boasted " open mind " so often, I find, ignores the logic of facts, especially when these are unpalatable, and produces schemes of development and expansion which seem ludicrous to those of us who are in daily touch with practical realities. Hence, and in accordance with my General's wishes, I have steadfastly refused to indulge in any flights of fancy.

We are honestly and soberly trying out every link in the chain, basing our tests on what we know of war. This method will, I believe, provide the surest foundation for those to build on who come after us. Some may be present to-night. If so, I sincerely trust that they will be able to bear witness in after years that we laid the foundations well and truly.

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STANDARDIZATION OF PERMANENT WAY.

By LIEUT.-COLONEL E. ST. G. KIRKE, D.S.O.

IN every branch of engineering the advantages of standardization are becoming increasingly recognized. A motor firm recently displaying all the components of their car in a shop window realized therefrom how many needless varieties of small parts such as bolts went into the car, and how great a saving could be made if they were all of one size.

The same thing has happened in the railway world. As a result of recent amalgamations of main lines in England, each system has found itself with a dozen different patterns of rails, fastenings, points and crossings, signals, etc. All these patterns worked very well, having no inherent defects, but it at once became obvious that the standardization of material on all the big English railways would make for cheapness in manufacture and all-round interchangeability.

A Permanent Way Standards Committee dealt with the problem, and as a result there is now throughout Great Britain one standard pattern of permanent way to which all railways are in process of conforming, as and when existing material falls due for renewal.

Although chaired track (*i.e.*, bull-headed rails on chaired sleepers) is practically universal in England, except for temporary or contractors' railways, in other parts of the world track is almost as exclusively formed of flat-footed rails resting on sleepers, with or without bearing plates in between, according to whether the sleepers are of soft or hard wood.

Flat-footed track is much lighter to transport and quicker to lay than chaired track (owing to bearing plates being much lighter than chairs), and it will inevitably be used on military railways.

So far there has been no attempt to standardize flat-footed track throughout the world, except in so far as the big consulting engineers may endeavour to do so on the various lines (in different countries) for whose designs they are responsible.

Standardization of track ensures that the rails shall be of standard length; that their dimension as to height of table and width of foot shall be identical; that the fish plates and bolts shall be of the same size; with holes at the same centres; that the bearing plates and dog spikes shall be the same; that there shall be a fixed number and spacing of sleepers in each rail length; and that every fitting or tool that can be dispensed with shall be eliminated, or unified with another from some other part of the track.

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As regards the length of rail, this must be governed to a great extent by its portability, and therefore its weight per yard. For instance, a 100-lb. rail 60′ long weighs nearly a ton. Its handling by an ordinary platelaying gang of eight men without special appliances would be practically impossible.

It may be argued that a rail, once in the line, does not need handling, and this point is very sound in a country like England, where the railways have already been built, and transportation of rails consists of merely tipping them off wagons where they are wanted. In young countries, however, and on military lines, rails have to be carried by hand before they can be laid in the track. The limits of length sometimes accepted overseas are 45 feet for 80-lb. rails, and 36 feet for 100-lb. rails, each giving a rail weighing 1,200 lb. The length adopted by military, and some Indian railways, is 36 feet.

The height and depth of rails are so designed as to give the greatest strength for the least weight, and for this reason the old "square" dimensioned British Standard F.B. ("flat-bottom") rails, whose height and width of foot were the same, is now being replaced by the new B.S.F.B. rail, in which extra vertical stiffness is given by increasing the height while leaving the foot the same.

With regard to the fish plates, these must obviously be made to suit the rail section in all respects.

As to the fish bolts and nuts, it is clear that if every nut to be found on the permanent way, whether at the joints, heel-bolts of switches, check rail bolts, components of crossing, holding down bolts of bridge timbers, etc., are of the same size, one set of spanners will do for all of them. This reduces not only the number of spare parts, but also the tools which have to be provided. There seems no reason why every section of rail between 60 and 100 lb. should not have 1″ fish bolts, whether strength demands such large ones or not. The extra cost per mile of track would be negligible in view of the fact that if heavier rails were laid later on, as traffic developed, the same tools would still be used, instead of a fresh set having to be bought. It is, no doubt, this consideration which has led the Indian railways to use the same fish bolts for their 100-lb. and 75-lb. rails.

POINTS AND CROSSINGS.

In no part of permanent way can greater economy be effected than in points and crossings, for it is possible to select one, or at most two inclinations of crossing which will answer all ordinary purposes on any gauge. Indian railways (5′ 6″ gauge) have selected 1 in 12 crossings for their fast running, *i.e.*, passenger tracks, and the 1 in 8½ for goods yard work. In addition they use 1 in 10 crossings for passenger slips. South African railways (3′ 6″ gauge) find that all their work can be done on 1 in 9 crossings. In England practically

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every number of crossing from a 1 in 1½ rising by half numbers to 1 in 20 are stocked and used. The reason for this is that lines have to be run into or alongside existing buildings, and crossover roads occur on curves, etc., whereas in young countries, *buildings are sited to suit railways, not railways to suit buildings.*

This should be equally true of military lines, and the designer of turnouts for military use will bear in mind that they may have to be laid by half-trained or untrained men ; in gas masks ; under fire, or bombing from the air ; at night, when only occasional or even no lights may be allowed. Further, that when they are laid they may easily be destroyed, and the necessary material for replacement be hard to get at short notice.

A design of turnout for military railways (and it is for consideration whether civil lines would not also benefit from the same idea) should therefore ensure that

(*a*) Only one or at most two numbers of crossing should be used for all ordinary purposes.
(*b*) The whole turnout should fit into a definite number of rail lengths.
(*c*) No rail, or at most only one rail, should have to be cut to fit into the "lead" of the crossing.
(*d*) The divergence at the heel of switch should not be less than the width of the foot of the rail.
(*e*) The switch rails should be so planed that *any rail can be used as a stock rail*
(*f*) The same length of switch should be used on all turnouts, even if there were two or more numbers of crossing.
(*g*) The bearing plates riveted under the crossing should correspond with the standard spacing of sleepers.
(*h*) There should be a minimum of interference with the running road while the turnout is being laid.

(*a*) As regards the use of as few different numbers of crossings as possible, this has been touched upon above, and the advantages are self evident. On the 4′ 8½″ gauge a 1 in 10 (radius of curve 942 feet, i.e., 2 gauge × number ²) and a 1 in 7 (radius 461 feet) should meet all ordinary requirements.

(*b*) and (*c*). The importance of the whole turnout fitting into a definite number of rail lengths, and the avoidance of rail cutting, can be gauged by the experience of the B.E.F. in France, where the existing French turnouts seem to have governed our designs. Over ten thousand 1 in 8 crossings were laid by our railway troops, of the design shown in Fig. 1.

It will be seen that to fit the turnout into an existing track, two rails have to be cut to complete three whole rail lengths ; that several rails have to be cut to fractions of an inch ; that there is not a single

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standard 36′ rail in the whole arrangement, and that, in short, there are no less than 12 rails of odd or special lengths.

Assuming that the 9-metre and 6-metre stock rails had to be used, Fig. 2 shows how the turnout could have been rearranged to eliminate all but four cut rails, namely, two to complete three whole rail lengths, and two for the closures to the crossing. All four " specials " can be cut from two standard 36′ rails. The slight increase of " lead " (or distance between the heel of the switch and the nose of the crossing) involved by this arrangement is of no practical importance.

When the time taken to measure up, cut, and re-drill rails is taken into consideration, plus the waste of material represented by rail ends, it is not too much to say that the design in Fig. 2 would have effected in France a saving, as compared with Fig. 1, of between a hundred thousand and a quarter of a million pounds.

For anyone who has a free hand to choose and design the crossings to be used on a military railway, the problem is to find the flattest crossing which will fit into 2, 3 or 4 rail lengths as the case may be, having regard to the nature and speed of the traffic, the rigid wheel base of the rolling stock, the curvature involved, and the gauge.

With 36′ rails, 72 feet are available in two rail lengths (plus expansion gaps which adjust themselves with other rails in the turnout, and do not need special consideration).

Of this 72 feet, 1 foot must be allowed between the end of the rail and the toe of the switch for the fish plates ; then comes the length of switch, and, with flat-footed rails, this must not be less than about 15′, or the stock rail will always give trouble by bulging outwards. At the other end of the 72 feet, room must be left for the nose of the crossing, and for the fish plates of its rails to be put in without their nuts fouling each other. This distance increases with the flatness of the crossing, but is not less than five or six feet from the nose.

Of the 72 feet, some 22 feet are thus unavoidably taken up, leaving 50 feet for the " lead."

Each gauge has a factor by which to multiply the number of the crossing for the purpose of finding out the lead. On the 4′ 8½″ gauge the factor is 6·7, and it follows therefore that a 1 in 8 crossing cannot be fitted into two rail lengths unless the proper lead required (*i.e.*, 6·7 × 8 or 53·6 feet) is shortened.

If the lead is shortened, the sharpness of the curve is automatically increased until it is as sharp as the curve to a 1 in 7 crossing. This being the case, it is simpler to adapt the 1 in 7 crossing whose radius (461 feet) is no less than that of the 1 in 8 used in France.

Since 16′ is already earmarked for fish plates and switches, and a 36-feet rail is going to be used in the lead, it follows that the overall length of the crossing unit must be 72 less 52, *i.e.*, 20 feet, and the nose must be 11 feet from the end of the 36′ lead rail so as to give the proper lead of 47 feet. Fig. 3 shows a design embodying these

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features, and it was found that a platelaying party, who had never seen the arrangement before, put in a turnout in about two-thirds of the time taken by a party who were familiar with the arrangement of the 1 in 8 used in France, the latter party taking 90 men-hours. With 45′ rails, a 1 in 8 can be very easily designed to fit into two rail lengths on the 4′ 8½″ gauge. There is plenty of room in 90 feet for a 1 in 8, and all that has to be done is to make the wing rails of the right length to add up with a standard rail to the proper lead: *i.e.*, the wing rail must be 53·6 less 45, making 8·6, say nine feet.

(*d*) Since no rails are to be cut, the nearest that the two rails at the heel of the switch can be put to each other is when their feet are touching. This means that the distance of their running edges apart, or "divergence," is the same as the width of the foot of the rail, and that the flangeway at the heel of the switch is the difference between the width of the top and bottom of the rail. With the 75 lb. B.S.F.B. rail (old or new pattern), this gives a flangeway of 2⅜″, which is ample to prevent an open switch acting as a check rail, unless wheel flanges are very worn.

(*e*) Planing the underside of the switch to ride over the flange of the stock rail is a most important point, and follows accepted practice in the North American continent, S. Africa, and elsewhere.

In effect it means that the switch can be applied at any point along any rail with no more work than drilling a few holes for the heel bolts and slide chairs, and that the stock rail retains its full strength. (In the form of stock and switch rail frequently met with on flat-footed track, the bottom flange of the stock rail is planed away, thus weakening it both vertically and horizontally. In the type in which the slide chairs are riveted to the stock rail, the rivets often get loose and ultimately break off, leaving the track unsafe until they are replaced.)

With the type of switch planed to over-ride the foot of the stock rail, repairs of a damaged turnout can be carried out much more quickly, since any rail can be taken from the siding, for the time being, to act as a stock rail, and only the switch blades and crossings have to be carried to site. This might mean the saving of much time, if motor transport were available to allow several places of a damaged line to be put in hand and repaired simultaneously. Another advantage of this type of switch is that it can be used during relaying work to avoid the cutting of closures.

(*f*) As stated above, a 15′ switch is the shortest which will avoid trouble caused by the stock rail bulging when flat-footed rails are used. It can be used for flatter crossings up to 1 in 10, and since switches are at best only a compromise, there seems to be no object in using any other length on military railways, where simplicity and uniformity are all-important.

In this connection it must be said that some designers attempt to lay the lead tangential to the *switch* with or without a short straight

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through the crossing, instead of tangential to the *main line* and the crossing, which is the simpler way. The condemnation of the former lies in two facts,

(i) it sharpens the curve some 25 per cent., which is just what one wants to avoid, more especially since it serves no useful purpose.

(ii) the advocates of the second method have admittedly to use the first when the turnout leaves a curve, otherwise, to quote an American authority (Webb), "the main curve must be transformed into two curves on either side of the frog . . . but this will introduce a very great and needless complication, and is never done. The more simple solution is to consider that the frog rail is a chord of the original curve, which narrows the track gauge by an amount equal to the mid-ordinate of that chord . . . for all ordinary curvature this theoretical defect is not vitally objectionable or even appreciable."

(With a 1 in 10 crossing, for instance, if it is assumed that the curve continues through the crossing for four feet on each side of the nose, the track is just over 1-10th of an inch tight to the 4′ 8½″ gauge.)

On military lines, apart from the above objections, if simple turnouts can be put in without blue prints or calculations (and they are

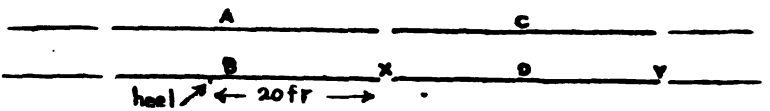

Fig. 5.

so put in on many first class railways even in peace), there is no virtue in confusing the platelayer by making an easy task seem difficult.

(*g*) The object of riveting the plates under the crossing at the same distance apart as the standard sleeper spacing is to ensure that, if a temporary turnout is wanted, or if crossing timbers are not available, none of the original sleepers need be displaced. If the crossing turnout is permanent, there is no difficulty about moving the original sleepers along to make room for crossing timbers. Fig. 4 shows a 1 in 10 crossing fitting into three 36-feet rail lengths. It will be noticed that in this case one rail is cut to form the closures. Both in this and the 1 in 7 the wing rails have been made the right length to simplify laying the turnout.

(*h*) There is no need to enlarge upon the importance of interfering with traffic as little as possible, and with "standard" crossings as described above the line need be broken for less than two minutes.

A short description of how a 1 in 7 "standard" crossing is laid into a running road may be of interest.

Supposing a turnout has to be put into the space occupied by rails "A," "B," "C," "D" (Fig. 5), with the crossing in "D." If rails drilled to take the slide chair bolts are available, it will pay to change them for rails "A" and "B."

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The length of the crossing unit, *i.e.*, 20 feet, is measured from joint " X " in rail " B," and this is where the heel of the switch will come. The position of the holes for the heel bolts can then be marked off (with a fish plate as guide) and drilled. Fish bolts at " X " and " Y " are loosened, and spikes along rails " B " and " D " are partially drawn. Slide chairs are substituted for bearing plates where the switch is to come, and one or two half spiked to hold gauge. So far nothing has been done to interfere with the running of trains at reduced speed, except the substitution of drilled rails for " A " and " B."

When the line is blocked, joints " X " and " Y " are broken, end " X " of rail " B " is swung open, rail " D " is pulled down 20 feet, and the crossing unit " Z " put in after the bearing plates on the sleepers concerned are removed. Both ends of the crossing are fished up, and the switch " S " after being fished up to end " X " of rail " D " is spiked home against rail " B " (Fig. 6).

A few spikes are driven home along rail " D " and on the crossing. The track is then once more ready for through running, on the

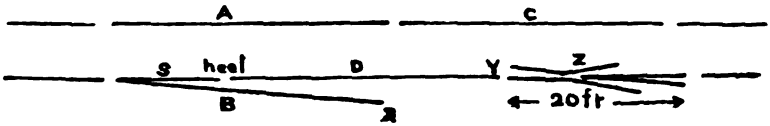

Fig. 6.

original sleepers, which have in no way been unpacked. The above placing of the crossing can be done in less than two minutes.

The remainder of the work can then be proceeded with at leisure, consisting in completion of spiking the through road; sandwiching in sleepers for turnout; drilling rail " A " for heel of other switch, and fitting slide chairs, drilling rail " C " for check rail (which rests on the original bearing plates); crowing and fixing lead rail; fixing stretcher rods, pull rod and lever, after scarfing extensions on to the two sleepers at toe of switch; fixing other check rail, etc.

Throughout the operation, rails " A " and " C " remain unbroken except in so far as drilled rails may be substituted for them. Even so, it will often be found best to leave the drilling of the holes for heel bolts to be done at site.

It is not suggested that these standard crossings will meet all the exigencies of a military railway, but under ordinary conditions they will suit 95% of the turnouts required, and as such are well worthy of adoption.

From the above it will be seen that, by making its wing rails the right length, there can be designed for any rail length on any gauge one or more crossings which can be fitted into a definite number of rail lengths, without involving the cutting of more than one rail at

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most for the lead. Further, such crossings can be selected, as regards inclination and curve lead radius, to suit all the requirements of traffic and wheel base. Since such is the case, it seems to be not only a waste of money to use any crossings which do not fulfil these conditions, but also a needless waste of time when the laying out of stores yards and depot sidings (matters of serious consequences in the conduct of a campaign) is involved.

Lest it be thought that there is any difficulty about manufacturing the above, it may be said that both with 100-lb. rails 45 feet long, and with 75-lb. rails 36 feet long, half a dozen firms in England have tendered for switch blades, points and crossings on the above design without question.

Many lines have a custom of using coach screws for holding down bearing plates and slide chairs through a turnout, thus necessitating a special set of box spanners which are all extra to carry about. If, however, such bearing plates and slide chairs are made with four holes for dogspikes, these will be found quite satisfactory, and special spanners for coach screws can be done away with.

CURVES.

It is sometimes thought necessary to have rails of special lengths, *e.g.*, 35′ 6″, 33′, 30′, etc., for curves, their ends being painted different colours. This is, however, not the case if joints are staggered round curves, as they generally are, except on English railways, whose curves are in most cases very easy, and the track much heavier than F.F. track.

If the length of the curve is known, all that has to be done is to cut one rail into two parts, whose difference in length is the same as the difference in length of the inner and outer rail round the curve. The stagger can then be given by putting the shorter length on the inner rail at the beginning of the curve, ending up with the longer portion on the outer rail.

The difference in length of the inner and outer rail round a curve is given by the formula

$$\text{Difference} = \frac{\text{Length of curve} \times \text{gauge}}{\text{radius.}}$$

If, for instance, the inner rail is found by this formula to be four feet shorter than the outer, one 36′ rail can be cut into one 16′ and one 20′ length.

The use of standard rail lengths in crossings has been dealt with above, so the need for special rails disappears, thus simplifying stacking in storeyards by cutting out the need for sorting. In the few cases where rails may have to be cut to keep their joints away from the centre of a bridge girder, this can be done on the spot.

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FIG. 1.

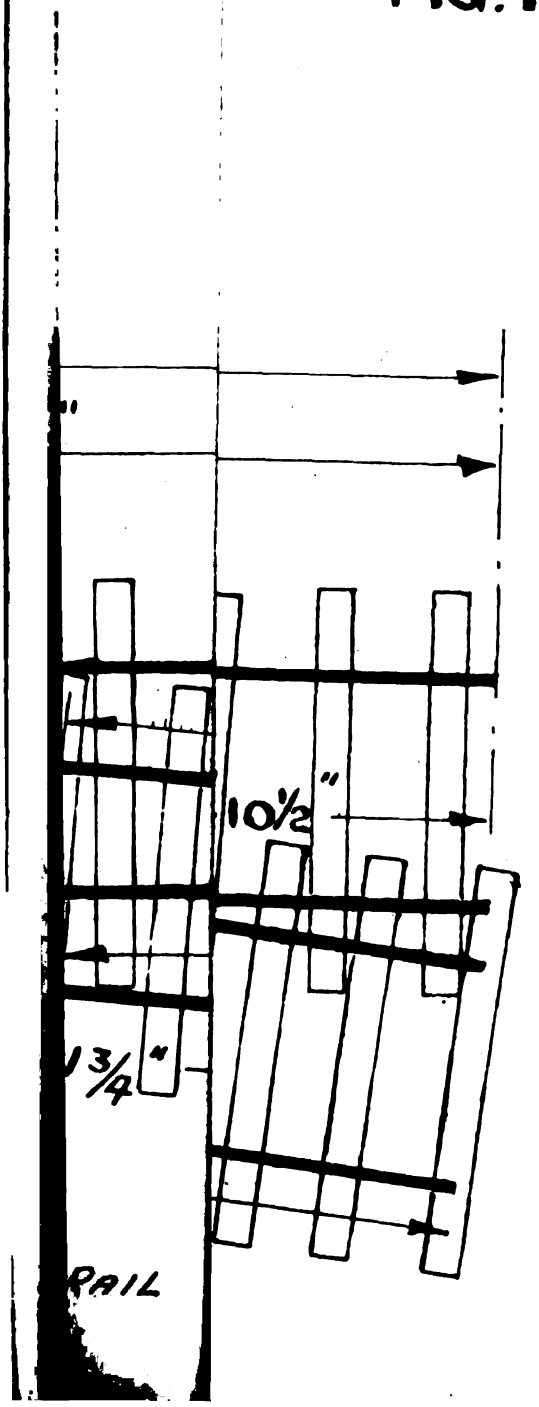

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Fig. 2.

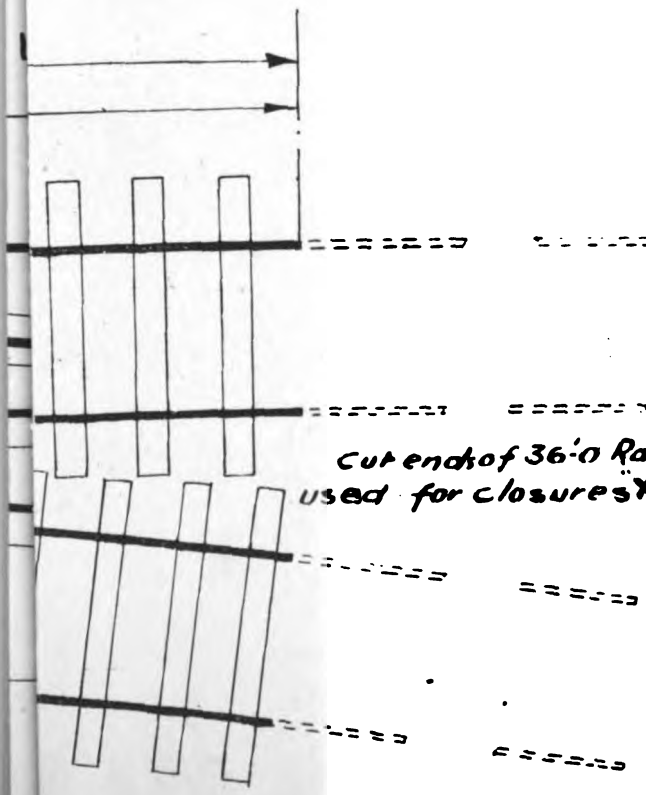

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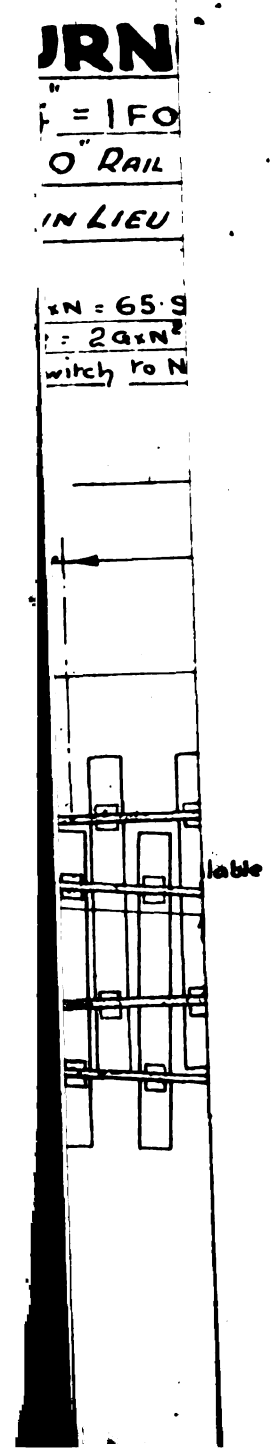
FIG. 3



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PALESTINE.

A Lecture delivered at the S.M.E., Chatham, on December 6th, 1928, by FIELD-MARSHAL THE VISCOUNT ALLENBY, G.C.B., G.C.M.G., D.C.L., LL.D.

TOPOGRAPHY AND HISTORY.

PALESTINE and Syria form, geographically, one country; lying between the Mediterranean Sea and the Arabian Desert. It is a tract of land 70 to 100 miles in width, and about 500 miles in length; bounded on the north by the Taurus Mountains, and on the south by the Desert of Sinai.

Parallel to the coast, southwards from the Taurus, are two mountain ranges; with, between them, a deep valley—the Lebanons and their valley—forming Syria. These mountains rise, snow-capped and well watered, the western range to a height of 7,000 feet and the eastern—Mount Hermon—to a height of 9,000 feet.

South of the Lebanons, the valley sinks rapidly, nursing the River Jordan, through Lake Huleh, to Lake Tiberias (Galilee) which is some 700 feet below the level of the Mediterranean. Sixty-five miles further south is the Dead Sea—1,300 feet below sea level. The length of the River Jordan, from its source in the Lebanon to its mouth in the Dead Sea, is roughly 130 miles. Its valley, a volcanic rift, is the deepest depression in the earth's surface.

The western range of Lebanon runs in a southerly direction; is broken by the Valley of Esdraelon; rises again, and throws out a branch to Carmel on the coast; then, continuing southwards, it forms the mountains of Judea—on which stand Jerusalem and Hebron. South of Hebron, the range sinks to Beer Sheba on the rim of the Desert.

The eastern range, on the left side of Jordan, forms the Hauran and the plateau of Gilead and Moab—the present Trans-Jordania; beyond is the Arabian Desert.

The western range constitutes the centre, or backbone, of Palestine. A rugged ridge of limestone, it rises, at Jerusalem, to about 2,700 feet—at Hebron, to 3,000 feet above sea level. Westwards, it falls gradually to the plain; its eastern face drops precipitously to the Jordan Valley and the Dead Sea.

Thus Palestine, including Trans-Jordania, is divided into four long strips; the Maritime Plain, the Judean Mountains, the Jordan Valley, the Eastern Range.

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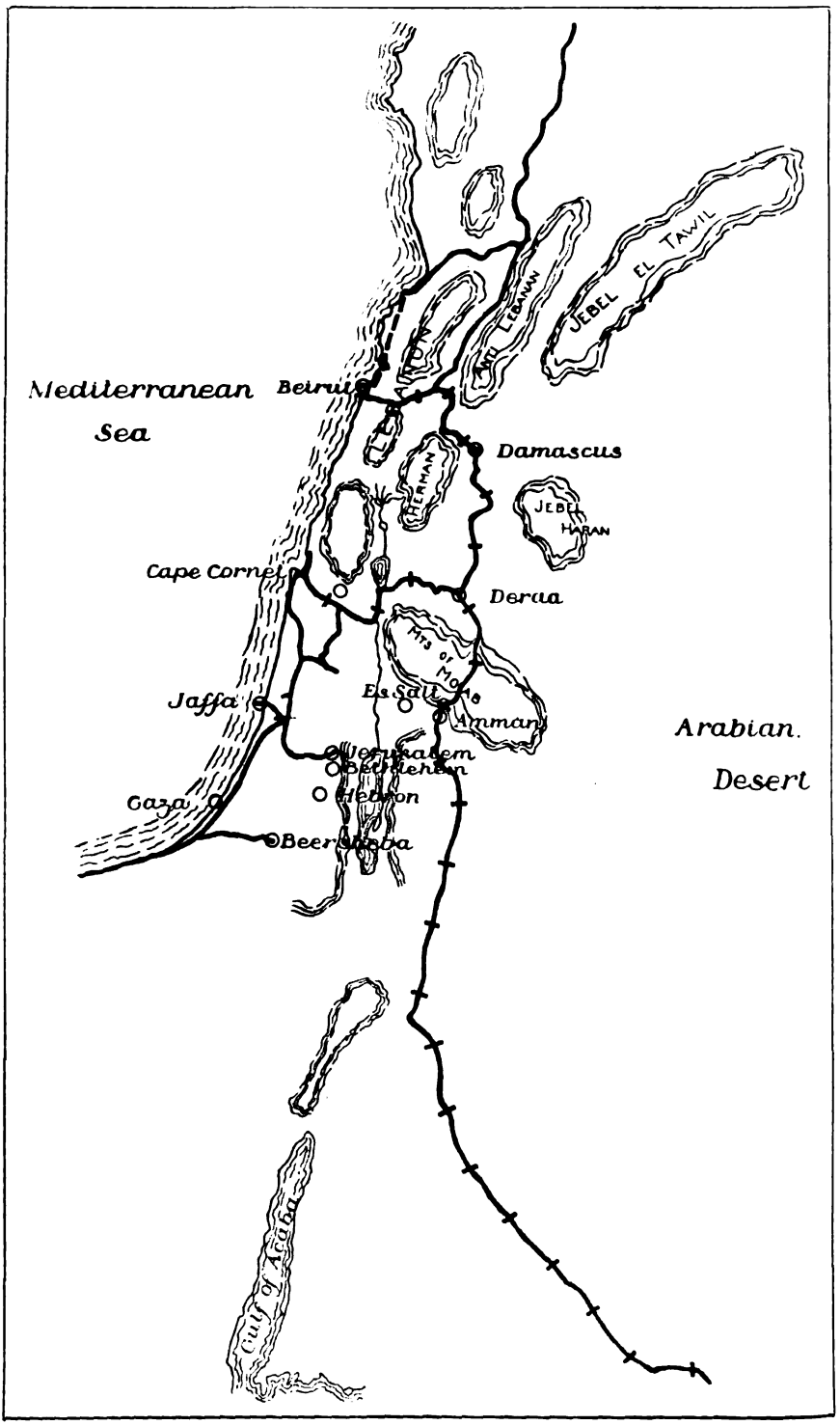

General Map.

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A section taken from Jaffa, through Jerusalem, to Mount Nebo in Moab, shows a rise from sea level at Jaffa, to 2,600 feet above the level of the sea at Jerusalem ; a fall to 1,300 feet below sea level at the Dead Sea ; then, a rise to 2,700 feet above ; in a distance, west to east, of 70 miles.

The ancient high road between Africa and Asia lies along the Maritime Plain, the trade route and battle path of rival civilizations for thousands of years.

Carmel is united to the main range by a ridge which is pierced by the pass of Megiddo—also known as Musmus, or Lejjun. There is also a pass between Carmel and the seashore. Northwards, across the fertile plain of Esdraelon, the road runs, on either side of Lake Tiberias, to Damascus, Aleppo, and the broad lands drained by the Euphrates.

This way came the Hittites, from Asia Minor ; this way marched the victorious Ethiopians, after their conquest of Egypt (see II Chron., xiv, 9). Assyrians, Egyptians, Persians, Greeks, Romans, all have fought and traded on that well-beaten track.

By this road, too, came the Plague, travelling with the armies from the Delta swamps and the dread Serbonian bog on the Egyptian frontier. It decimated many armies, from Sennacherib to Napoleon Bonaparte.

The early dwellers on the coastal plain, the Canaanites, were driven out or absorbed by the Philistines who arrived from Crete, probably, at about the time when the Israelites left Egypt. The children of Israel were not able to fight their way through the fierce tribes of Palestine's Desert boundary ; they passed south and east of the Dead Sea, and made their entry by crossing the Jordan, near Jericho, establishing themselves in the high hills. Thenceforward, though masters of the mountains, they never got a permanent footing on the plains. Amid their hills they held their own, in the low ground the Philistines usually prevailed.

Jerusalem's importance lies in its position on the plateau, at the junction of the roads and passes. Southwards, from Jerusalem, along the crest of the ridge, is the road to Beer Sheba. Northwards, it runs by Bethel to Nablous, and onwards to Esdraelon. Several passes communicate with the coastal plain. The Wadi Sunt to the south-west is the old Vale of Elah—scene of many a conflict with the Philistines—which led to their city of Gath. The reputed site of Gath is the limestone bluff at the entrance to the Pass, Tell es Safi, called by the Crusaders Blanche Garde. North of this is the Vale of Sorek, or Wadi Surah, through which runs the railway. Further north, by Bab el Wad and Khuryet el Enab, the modern road leads to Jerusalem. Next, we find the Vale of Ajalon, or Yalu ; and, north of this, Bethoron the Upper and the Lower—Beit Ur el Foka and Beit Ur el Tahta. Eastwards, roads cross the Jordan Valley,

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connecting Jerusalem with Jericho, and with Es Salt and Amman, giving access to the cornlands of Gilead; and leading, through Edom, to the Gulf of Akaba and the Red Sea.

All these roads converge at or near to Jerusalem, giving facilities for travel and commerce in all directions: hence the great prosperity of the city under the Warrior King David and Solomon, his son.

Projecting from the western foothills is a remarkable feature; a hill, rising to a height of 700 feet—Gezer, or Abu Shusheh—the Mont Gisart of the Crusaders, beside the road to Jaffa. High, rocky, yet fertile in soil, and with abundant springs of water, it guards the passes from Jerusalem, as they open on the plain. When Solomon came to the throne, Gezer was a Canaanite fortress. It was taken by Pharaoh of Egypt, who destroyed the town and killed its inhabitants. Solomon took Pharaoh's daughter to wife, and obtained Gezer as her dowry. The possession of this stronghold assured access to, and control of the Plain, the great High Road; an asset which the business capacity and diplomatic wisdom of Solomon enabled him to use to his great advantage.

THE CAMPAIGN IN PALESTINE, 1917–18.

The original idea in keeping a force in Egypt was to guard our communications with the East. General Murray's advance to the Palestine border, in 1916–17, was the surest way of protecting the Suez Canal. Later, the threat to Mesopotamia by the so-called Yilderim Army of Von Falkenhayn, from Aleppo, led to our counter-stroke at his flank through Palestine.

I assumed command of the Egyptian Expeditionary Force in June, 1917.

During that summer, the Force lay on a front of twenty-two miles from the sea coast, near Gaza, to Gamli, facing the Turkish Army which held a position, from Gaza to Beer Sheba, thirty miles long.

Our army was occupied in refitting and reorganizing. It consisted, by the end of the summer, of the Desert Mounted Corps of three Divisions, under General Sir Harry Chauvel, and seven Divisions of Infantry. The seven Divisions were organized in two Army Corps, the XX. under General Sir Philip Chetwode, and the XXI. under General Sir Edward Bulfin. In addition, there were some attached units, including a small French contingent and a small Italian contingent.

My plan was to assume the offensive as soon as our preparations were complete, and to capture Beer Sheba, thus turning the enemy's left.

To distract the enemy's attention, it was also decided to attack Gaza, and a scheme for this was prepared by General Sir E. Bulfin, in co-operation with the Navy.

The operation against the Turkish Left was assigned to Sir Philip

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Chetwode, commanding the XX. Corps. His main difficulties were transport and water, as his task involved a long desert march. Practically the whole transport, including 30,000 camels, had to be allotted to him for carrying food and ammunition, and preparations were put in hand for a railway, to be pushed rapidly towards Beer Sheba.

The line of approach was under view of the Turkish positions, and secrecy of preparation was a difficult matter.

A bombardment of the Gaza lines began on the 27th October; and, after a long night march, Beer Sheba was attacked on the morning of the 31st, from the south and east. By nightfall, Beer Sheba was in our hands. This victory laid open the Turkish left.

Gaza was attacked on the 1st November, and good progress was made on that and subsequent days.

During the consolidation of our positions round Beer Sheba, fighting was bitter and continuous; till, on the 6th November, the Turkish line succumbed to a renewed attack and was rolled back in confusion.

Gaza fell on the 7th, and the Turkish armies retreated, mostly northwards along the plain, and a few by the mountain road towards Hebron.

All of our troops for whom transport was available—three Mounted Divisions and two Infantry Divisions—were launched in pursuit along the Plain, and another Division, the 53rd, followed those of the enemy who had chosen the road to Hebron.

There was hard fighting, by all arms, during the pursuit, which was pressed with vigour, till on the 15th the Hill of Gezer—or Abu Shusher—was taken by assault, and the Turkish army was cleft in two. One portion retired northwards, by the Plain of Sharon; the other went east, up the passes, towards Jerusalem.

The passes were steep, narrow, and well entrenched; it behoved us, therefore, to follow the enemy up closely, and give him no time to organize defence. Consequently, the Yeomanry Division were sent, on 17th November, *via* Bethoron, to move on Bireh (Bethel). The 75th Division took the road to Jerusalem, *via* Bab el Wad; its right was guarded by the Australian Mounted Division. The 52nd Division went up the Valley of Ajalon (Yalu) towards El Jib (Gibeon).

The Ridge was won, but bad weather, difficult ground, strong resistance by the enemy, and the exhaustion of our men brought about a pause, and not until reinforcements became available could the Turks be driven from their last positions.

Finally, they withdrew northwards, towards Mount Ephraim, and eastwards towards Jericho.

Jerusalem was handed over by the Mayor on the 9th and our official entry was made on the 11th December. Meanwhile, the

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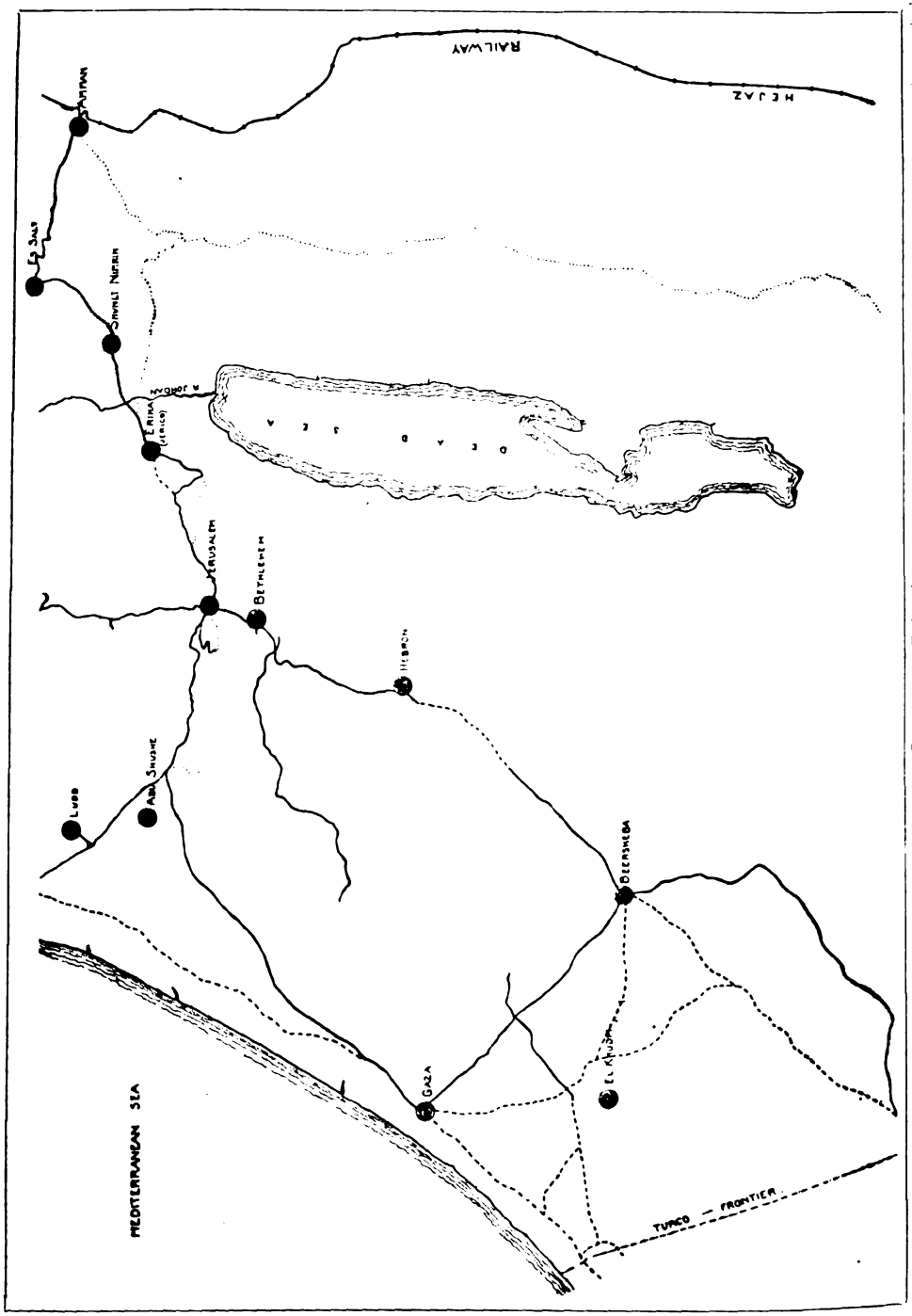

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Anzac Mounted Division and some of the XXI. Corps had occupied Jaffa on the sea coast, and faced the Turks on the Plain of Sharon.

During December, the enemy made a great effort to retake Jerusalem from the north, and there was hard fighting, but by the end of the month we were quite firmly established.

The next few weeks were devoted to improving communications, replenishing supplies and ammunition, and to preparations for the crossing of Jordan. There was sharp fighting in the advance to Jericho, which was occupied on the 21st February, the Turks crossing to the left bank of the river and destroying the bridge.

After minor but necessary operations to gain space and freedom of manœuvre, we crossed the Jordan on the 21st March. An operation was then undertaken, a raid against the enemy's communications in Gilead, to break the line by which he supplied those of his troops who were opposing our Arab allies in the Hedjaz.

The 60th Division, the Australian and New Zealand Mounted Division, the Imperial Camel Corps Brigade, with attached troops, all under command of General Shea, carried out the raid.

Its object was to cut the Hedjaz railway, at Amman, and to join hands with the forces of King Hussein of the Hedjaz who were under the command of Sherif Feisal and Colonel Lawrence. Operations were hampered by exceptionally cold and heavy rains; but Amman was reached, and the railway cut, though only temporarily. We then withdrew, and by the 2nd April had recrossed the Jordan, leaving only a bridgehead guard on the left bank of the river.

Another raid was undertaken at the end of April, by two Divisions of the Desert Mounted Corps and the 60th Division. The object was to cut off a body of 5,000 Turks who had occupied the pass of Shunet Nimrin in the Jordan Valley, also, by seizing Es Salt, to deprive the enemy of the harvest from the cornlands of Gilead and Moab.

Es Salt was gained; but enemy pressure was heavy, and its retention would have been too costly, so our troops were withdrawn.

These two raids, though not completely successful, had the good result of making the enemy very nervous, and they caused him to detach troops which relieved pressure on our Arab Allies and elsewhere.

During April, two British Divisions, the 52nd and 74th, were sent to France, as well as nine Yeomanry regiments, five and a half siege batteries, ten British battalions and five machine-gun companies. By the end of April, these troops had been replaced by Indian Cavalry and Indian Infantry. In May, fourteen more battalions of British Infantry were withdrawn for France, and, in July and August, a further ten battalions were replaced by Indians.

During those months, training and reorganization were continuous, but many minor operations and raids were carried out, while plans for a renewed campaign were maturing.

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At the beginning of September, the strength of the enemy was calculated as 4,000 sabres, 32,000 rifles, 400 guns. The British Army, with the French and Italian contingents, numbered 12,000 sabres, 57,000 rifles, 540 guns.

The VII. and VIII. Turkish Armies, west of Jordan, had 17,000 rifles and 268 guns. The IV. Turkish Army, east of Jordan, had 6,000 rifles and 74 guns. On the Hedjaz railway were 6,000 Turkish rifles and 30 guns, while a reserve of 3,000 rifles and 30 guns were between Tiberias and Haifa.

The two raids which we had made in the spring of the year, and our maintenance during the summer of a large force in the torrid heat of the Jordan Valley, led the Turks to suppose that we intended to make our next great effort against his left.

The bulk of the Turkish armies, west of Jordan, lay south of the line—Jisr ed Damich—Nablous—Tul Keram—to the sea. Their line of communications led north; the vital points thereon being El Afule, Beisan, and Deraa. Deraa was out of our reach, but accessible to our Arabs. El Afule, in Esdraelon, and Beisan, in the Valley of Jezreel, further east, could be reached by our cavalry. El Afule and Beisan lay sixty miles distant from our left, the ridge of Carmel and the pass of Megiddo intervening.

We chose to make our attack through the coastal plain.

By reducing our strength in the Jordan Valley, and by withdrawing reserves from the line north of Jerusalem, five Divisions were concentrated, with 383 guns, in front of the enemy's right, in the Plain of Sharon; as well as two Cavalry Divisions and the Australian Mounted Division, with two squadrons of French African Cavalry.

In the Jordan Valley, Major-General Sir Edward Chaytor had the Australian and New Zealand Mounted Division, a Brigade of Indian Infantry, two Jewish Battalions and two West Indian Battalions. A mobile column of the Arab Army was at Kasr el Azrak, fifty miles east of Amman.

To ensure secrecy, movements towards and upon the coastal plain were only made by night; and the orange and olive groves of Ramleh, Ludd and Jaffa, were used as hiding-places by day. Moreover, by this time, our aeroplanes had command in the air, preventing observation by the enemy's aircraft.

At 4.30 a.m. on the 19th September, the Artillery in the Coastal plain opened intense fire—lasting fifteen minutes—while the Infantry deployed. Two destroyers assisted, by fire from the sea, against the road which follows the shore northwards.

By 5.30 a.m. the Infantry had opened a way for the Cavalry, who swept along the shore, and by noon had covered 18 miles. At dawn, on the 20th, they were through the passes and moving across Esdraelon. Afule junction was seized and Beisan was reached by evening. One brigade rode to Nazareth, capturing General Head-

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quarters. Marshal Liman Von Sanders narrowly escaped by motor-car. The Australian Light Horse took Jenin at a gallop. Thus, by nightfall on the 20th September, every line of retreat west of Jordan was blocked.

Meanwhile, the Infantry attack had gone forward, through the hills of Galilee, and the Turks were driven in rout through the defiles, while aeroplanes systematically harried their dense columns by bomb and machine-gun. The fugitives, emerging on Esdraelon, and Jezreel, or crossing the Jordan, fell into the hands of the Cavalry, who held all exits. At nightfall on the 21st, the battle, west of Jordan, was at an end, and the Turkish Armies had ceased to exist, at any rate as organized troops.

In the Jordan Valley, Chaytor, on the 21st, took many prisoners at Jisr ed Damieh. He went east on the 22nd against the retreating IV. Army. On the 24th he entered Es Salt, and on the 25th he captured Amman after a hard fight. Half the IV. Army had retired north, the rest fell into his hands later on their way home from the south.

Feisal and his Arabs took a useful part in attacking the IV Army, and pushed with vigour in pursuit on to Damascus.

Without halt or check, our mounted troops chased the fleeing Turks, relentlessly following them up until Damascus was won.

The XXI. Corps followed the Coast road, by Haifa, Acra, Tyre, Sidon, to Beirut which place it reached on the 10th October. French ships of war were already in the harbour.

Damascus fell to the Desert Mounted Corps and the Arabs on the 1st October. On the 9th October, the Desert Mounted Corps pushed troops on to Homs, which was occupied on the 15th. On the 13th, the XXI. Corps Cavalry entered Tripoli. Aleppo was reached by the Mounted Troops on the 25th and some hard fighting ensued, but the town was not taken till the Armistice allowed our advanced guards to enter on the 31st of October.

In 40 days of fighting, the Egyptian Expeditionary Force had captured 360 guns and 75,000 prisoners, including 200 officers and 3,500 other ranks of Germans and Austrians. Our losses in battle had been under 5,000. Of the Mounted Troops, the 5th Cavalry Division had covered over 500 miles, losing only 21 per cent. of its horses.

After the Armistice, and during the negotiations for peace, the Turks evacuated Cilicia, and were replaced by our troops.

We occupied and held Bozanti, at the western exit of the Taurus tunnel, the bridge over the Euphrates at Jerablus, and the chief places in Cilicia.

Cilicia, Syria and Palestine remained under the Military Administration of the General Officer commanding the Army of Occupation, until the question of Mandates was settled.

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THE "MECHANIZATION" OF FLEETS AND ARMIES.

By V. W. GERMAINS, *late Rifle Brigade.*

". . . THE army of the future will follow in the footsteps of the navy of to-day. Once a maritime nation could build scores and hundreds of galleys; to-day many seafaring powers cannot afford half a dozen capital ships; even in the Great War we only possessed between twenty and thirty. . . . In round numbers the strength of such an army will be 2,000 fighting machines and 60,000 of all ranks. A microscopic force when compared with the horde armies of 1914–18 . . . if the *organized* force of my sketch had existed we could . . . have decimated these hordes as surely as Alexander decimated the Persians at Issus and at Arbela . . . the artillery, or mechanical cycle of war, will reintroduce the highly professional army and conscription will be relegated to the troops of the second line, the militia which will occupy the enemy's country after his mechanized forces have been defeated, driven back or destroyed." Colonel J. F. C. Fuller, *On Future Warfare*, pp. 388 *et seq.*

The acid test of all theories is that of practical experience. We have at sea authenticated records of a process of transition from wooden ships, dependent upon man-power to handle their sails and guns, to ships of steel, dependent upon steam, electricity, and the petrol-motor for power of fighting and of manœuvre. It is a process which has endured for upwards of ninety years, which has witnessed revolutionary changes in weapons and methods and which has not alone absorbed vast sums of money in ship-construction and in experimental work, but which has been "tried out" and tested in a series of wars costing the lives of very many thousands of men. The student surveying the series of confident predictions which head this chapter might reasonably anticipate that "mechanization" at sea would have produced results at least analogous to those which it is forecasted as being about to produce on land—and he is the more justified in expecting this, since our gallant and gifted author expressly tells us that, "The army of the future will follow in the footsteps of the navy of to-day." It is somewhat disturbing, therefore, to find, at the very outset of our problem, that the actual working of "mechanization" at sea by no means supports Colonel Fuller's theories, but, on the contrary, it very emphatically confutes them.

Nelson at Trafalgar had 27 "capital" ships manned by 17,486 men. He had three frigates and a sloop. These took no part in the battle, but if they are included we get a total of 31 units with,

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in round numbers, 18,500 men. Jellicoe at Jutland had 36 "capital" ships with 33,838 men; he had besides, 34 cruisers and light cruisers with 16,837 men, and 77 destroyers with 6,208 men, a grand total of 147 units with 56,883 men.* Isn't this a somewhat significant commentary upon the sweeping assertion that "mechanization" will reduce the size of armies *because* it has reduced the size of fleets? And doesn't it come as a rather baffling paradox to discover that whereas Nelson's *Victory*, a muscular ship, needed a crew of only 837 men, Jellicoe's *Iron Duke*, a box of engines, needed 1,022?

But when we consider the aggregate totals of "mechanized" and non-"mechanized" fleets alike in number of units, their cost, and the number of men needed for their complements, we are struck by the same tendency of "mechanization" to produce fleets vastly larger, and requiring vastly increased numbers of *men*. Our wooden fleet reached its maximum strength in units in the year 1809 with 728 warships displacing 501,596 tons. The high-water mark in manpower was reached the year following with 145,000 men, it kept at this level till 1812, after which it declined. In 1805, during which we faced a combination of the greatest naval powers in the world, the Navy had a strength of 534 warships, displacing 407,814 tons, and manned by 120,000 men.† In 1914, after ninety years of "mechanization," and in time of peace, we had 648 warships, displacing 2,333,223 tons and manned by 146,000 men.‡ By 1918, these figures had expanded to 1,354 warships, manned by 407,316 men, and displacing 3,247,078 tons, which does not include a modest little total of 754,111 tons, auxiliary ships, nor an office staff of 9,820, an industrial staff of 105,024, and 408,000 employed in dockyards, repairing establishments, etc. As concerns the relative cost of "mechanized" and non-"mechanized" fleets, the following figures are instructive. The year of Trafalgar cost us £15,035,630 in Naval Estimates; the years in which our wooden fleet reached its maximum strength, 1809 to 1811, brought us estimates varying from £19,578,467 to £19,822,100. The year of Jutland cost us £209,877,218, whilst the estimated cost for 1918 was £325,000,000. Not a very encouraging prospect for those who preach "mechanization" as a *cheap* method of waging war, is it?

But this does not exhaust our list of baffling paradoxes. It is part of the thesis of Colonel Fuller and kindred writers that "mechanization" will simplify the problem of leadership, it will replace "horde-armies," in which "numbers swamped efficiency," whilst according to an enthusiastic disciple it will make wars "short, sharp and decisive," and "save the blood of England's sons." But

* These are the official complements of the ships engaged as taken from Jane's *All the World's Fighting Ships*, of 1919. In reality, *Queen Mary* had 1,270 men instead of 1,000. Complements of other ships were proportionately larger.

† Clowes, *Hist. Royal Navy*, Vol. V, p. 8.

‡ First Lord's *Statement*, 1919–1920.

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whereas Trafalgar was an overwhelming victory, Jutland was an indecisive battle. "Mechanization," so far from simplifying the problem of leadership, rendered this infinitely more complex, for Nelson had not to cope with mines or torpedoes, he had not to arrange team-work between battleships, cruisers and destroyers, nor had he to deal with visibility as affecting fire-control at long ranges. Nor did mechanization "save the blood of England's sons." At Trafalgar, where our entire battle-fleet was desperately engaged, we lost 1,690 men, about nine per cent. of the numbers present; at Jutland, which was in reality a brush between fleets, we lost roughly 11 per cent., and the German ships, admittedly well-armoured, lost eight per cent.

Finally, as touching Colonel Fuller's general thesis that "mechanization" has reduced the size of fleets and will reduce the man-power needed for armies, it may be of interest to glance at the actual building programmes of the British Admiralty and their effect upon the growth of the fleet in size and the man-power needed.

The low-water mark in man-power was reached in the year 1817, long before the introduction of "mechanization," with 19,000 men. From 1818–1837 it hovered between 20,000 and 30,000 men. From 1840–1853–4 (introduction of steam) it varied between 34,000 and 44,000. The introduction of armoured ships in 1857 coincided with a strength fluctuating around 60,000 men. Masts and sails did not disappear entirely from the battle-fleet until about 1880. In the decade 1881–1890 we built, counting only "capital" ships:

2 *Conquerors*	6,200 tons	1881 and 7
2 *Colossus*	9,420 ,,	1882
1 *Collingwood*	9,500 ,,	1882
2 *Howes*	10,310 ,,	1884
2 *Ansons*	10,600 ,,	1885
1 *Benbow*	10,600 ,,	1885
2 *Sanspareils*	10,740 ,,	1887
2 *Trafalgars*	11,940 ,,	1887–88

Total, 14 battleships, displacing 148,520 tons.

In 1871–1900 we built:

8 *Royal Sovereigns*	14,200 tons	1891–2
2 *Barfleurs*	10,500 ,,	1892
1 *Renown*	12,350 ,,	1893–5
9 *Majestics*	14,900 ,,	1894–1896
6 *Canopus*	12,950 ,,	1897–8–9
3 *Formidables*	15,000 ,,	1898
3 *Londons*	15,000 ,,	1899–1900

Total, 42 battleships, displacing 433,750 tons.

During this period the man-power of the fleet expanded from 60,000 in 1888 to 100,000.

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In 1901–1910 we built:

2 *Queens*	.. ..	15,000 tons	.. 1902
5 *King Edwards*	..	16,350 ,,	.. 1901–3
3 *King Edwards*	..	16,350 ,,	.. 1903–5
(bought) 2 *Swiftsures*	.. ..	11,800 ,,	.. 1903
2 *Lord Nelsons*	..	16,500 ,,	.. 1904–5
1 *Dreadnought*	..	17,900 ,,	.. 1905–6
3 *Invincibles*	.. ..	17,250 ,,	.. 1907
3 *Bellerophons*	..	18,500 ,,	.. 1907–9–10
2 *Neptunes*	.. ..	20,200 ,,	.. 1908–9
3 *Indefatigables*	..	19,200 ,,	.. 1909–11

Total of 24 "capital" ships with displacement 404,100 tons.

The middle of this decade was marked by a slowing down in building, due to the disappearance of the Russian fleet. In 1902–3 manpower had expanded to 120,000 men.

In 1911–1916 we built:

2 *Colossus*	.. ..	20,600 tons	.. 1910–11
4 *Orions*	.. ..	22,500 ,,	.. 1911
2 *Lions*	.. ..	26,350 ,,	.. 1911
4 *King George V.*	..	23,000 ,,	.. 1911–12
4 *Iron Dukes*	.. ..	25,000 ,,	.. 1912–13
2 *Tigers*	.. ..	28,500 ,,	.. 1913
5 *Queen Elizabeths*	..	27,500 ,,	.. 1913–14–15
5 *Royal Sovereigns*	..	25,750 ,,	.. 1915–16
2 *Repulses*	.. ..	32,000 ,,	.. 1916

Total of 30 "capital" ships, displacing 747,150 tons, and built over a period of 6–7 years.

Excluding *Queen Elizabeths*, *Tiger*, *Royal Sovereigns* and *Repulses*, we built in five years preceding the declaration of war 17 "capital" ships, displacing 398,400 tons. The man-power of the fleet expanded from 120,000 to 146,000 men. Many more men would have been required but for Fisher's policy of "scrapping" obsolete ships. In the two years preceding the War we had a yearly average of 179,800 tons of warships under construction, nearly one-half of the total warship tonnage in 1805, and more than one-third of the total tonnage in 1809, the year of the maximum size of our wooden fleet.

In the period July 1st, 1915–June 30th, 1916, we had built 522,239 tons of warships, which actually exceeded the total tonnage of 1809.

These figures, however, are a conservative estimate. They do not include several ships, such as *Erin* and *Agincourt*, bought or confiscated for naval purposes on the outbreak of the War, and they do not picture the intensification of effort due to the short "life" of the modern warship as compared with the long "life" of the Nelsonic ship-of-the-line. *Victory*, launched in 1765, was still a first-class

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unit in 1805, and for many years after. Jellicoe's oldest battleships at Jutland were *Bellerophons* and *Neptunes* (1907–8–9).

The super-*Dreadnoughts*, *Orions*, *King George V.*, *Iron Dukes*, *Queen Elizabeths*, were babies in arms compared with *Victory*, infants of one and two; tiny toddlers of three and four years old. Taking period for period, a comparative statement of our fleet of 1916 with that of 1805, would include ancient *Admirals*, long broken up for the scrap heap; we should reach a total of close upon 100 battleships, which would rival even in point of mere numbers the battle-fleet of Nelson's days (116 sail of the line), whilst far exceeding these in man-power needed, displacement tonnage, and cost. The year 1914 actually found us with 70 "capital" ships instead of "between 20 and 30," as Colonel Fuller imagines, for our pre-*Dreadnoughts*, much more powerful than the German *Pommerns* which were actually present at Jutland, formed a very valuable reserve. It may be added that the vast expansion of the British "mechanized" fleet here described was even exceeded by that of the German, American and Japanese navies, in the period 1898–1916.

The actual course of "mechanization" at sea thus by no means supports the views of those who hold that "mechanization" on land will mean smaller armies and reduce the man-power necessary for these. The explanation of this apparent paradox is that these theories are based upon an economic fallacy. Labour-saving machinery does not displace human labour; on the contrary, it increases the demand for human labour, and the more machines we have, the more we shall need men. A glance at peace-industry reveals the tremendous growth of great industrial cities and an enormous increase in the number of operatives employed in industry.*

The tendency of fleets and armies to expand in size, the power of their weapons, the man-power needed to use these weapons, and of leadership to become more complex, is thus part of a general tendency of social organisms to expand in growth and of social leadership to become more complex. Is it wise to jump to the conclusion that this tendency, which has been continuous for centuries, and which has been helped and not retarded by labour-saving machinery, is, in its purely military aspects, about to undergo a sudden change eccentric to the general movement of social communities?

In dealing with a problem which is many-sided and complex, the student will be well-advised summarily to dismiss a great many fanciful analogies between tanks and barbarian horsemen; or tanks and battleships. The decay of the Roman Empire was the collapse of a political, and not of a military organism, and whereas it is impossible for a man to fight at sea standing on his own legs without support

* The population of England and Wales increased from 8,892,536 in 1801 to 37,886,699 in 1921; that of Germany from 24,831,396 in 1816 to 69,656,259 in 1925; that of U.S.A. from 5,308,483 in 1800 to 105,720,620 in 1920 (*Statesman's Year Book*, 1928). These are the three countries in which there have been the largest developments in labour-saving machinery.

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from a floating surface, he *can* do this on land. We cannot solve modern military problems by returning to the shibboleths of the eighteenth century, and in putting forward naval analogies, full allowance must be made for the very great difference in the technical problems involved. The sea is a vast plain; save where shoal-waters, rocks or narrows intervene, there is nothing to hamper movement nor, save for sea-fog, is there any bar to vision. This vast plain is threaded by trade-routes; war at sea resolves itself largely into the attack or defence of these, and " command of the sea " may be interpreted as the power to deny movement across the sea to an enemy whilst preserving freedom of movement for one's own side. Save for political considerations such as the Washington Conference, or the necessity of being able to use existing docking accommodation, there is no bar other than cost on the battleship's size; on the contrary, increased size means an actual economy in engine-power, first costs, and maintenance costs.

Yet even with these advantages the battleship represents a compromise between divergent elements in speed, armament, armour, and endurance. This compromise, which is inevitable, renders the battleship dependent upon light cruisers, cruisers, destroyers and submarines for scouting, " screening," commerce-protection, and blockade work. The battleship herself, whilst massively armoured, is built to fight at immense ranges; she can calculate her rolling " period," avail herself of " spotters " and " directors " to control her fire; she is armed with, save for " Big Bertha," the heaviest guns known to man, and is built to challenge the similar weapons of an enemy. Conditions on land are vastly different. There are such things as mountains, swamps, rivers, forests, great cities, towns, villages, all of them very serious obstacles to movement and vision. The tank is cramped as to size by the necessity of being able to utilize roads, railroads and bridges, and, above all things, by the necessity of reducing the size of the target, for her entire body is exposed to fire, whereas the bulk of the warship is submerged, and thus protected. Like the warship, she is a compromise between divergent elements in the way of speed, guns, armour and endurance, but unlike the warship, she is not free to increase her size. Her armour is protective only against infantry weapons, she cannot face the smallest quick-firing gun, and, considered as a gun-platform, she can neither calculate her " period " nor " register " on her target. If it is to be a *fire-fight* between the gun mounted on a tank and a gun of equal power stationary, no one can have any doubt as to what would happen.* The tank's real weapon is—shock tactics. If she can rush the gun before she gets " smothered," she can crush it either

* Col. Collins, Commandant of the Experimental Mechanized Force, said, in answer to a question by Capt. Oldham, R.N., " . . . we cannot get the gunnery efficiency in movement you have. . . . You have only to spend a few minutes in a tank to realize the great difficulty of bringing efficient fire to bear in movement."—*R.A. Journal*, April, No. 44.

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beneath her weight or by a rain of machine-gun fire with A.P. bullets at point-blank range. The tank is thus a close-quarter weapon like the destroyer, and success is largely a matter of moral effect and the exploitation of surprise. The greatly increased area to be protected as compared with the armoured ship, and the practical limitations on the size of a tank, render the problem of increasing the weight and thickness of armour to meet the menace of an improved anti-tank gun very complex. One cannot get something for nothing. Speed is perhaps the costliest item, armour comes next, the gain, if any, must be met by increased mechanical efficiency; one does not, however, increase the mechanical efficiency of one's engines 100 per cent. to 200 per cent. at one fell swoop. A possible solution is to increase the length of the tank, but we have to face the problem of road-curves, stresses on bridges, railroad-capacity. No doubt we shall get ultimately a multiple-tracked tank, and the "electric drive" may possibly afford a means of working with separate gun and power-houses, and "articulated joints," so as to be able to follow road and railroad bends.

But, however powerful the tank, the anti-tank gun will always move to meet it; the man fighting on his own feet will always have certain solid advantages over the man fighting mounted on a machine. The student is apt to be confused by hasty generalizations. He has such phrases as "Reign of the Bullet," "Half an inch of steel to cancel out half an ounce of lead," etc., literally hurled at his head. But there is nothing sacrosanct in the word *armour*. The resisting power of any steel plate depends upon the weapon which attacks it. Not alone this, but armour which is not protective becomes an added source of danger. The top of a turret will intercept a shell which would otherwise have passed over; the thin plate will cause a shell to explode destructively which might otherwise have gone "clean through." Tanks designed in defiance of these principles may become mere death-traps for their crews. Difficulties in the way of increasing tank armour have already been touched on. Increased length will mean a bigger target, a greater area to be protected, and it is difficult for the tank-designer to follow the path of the battleship designer and to concentrate armour on "vitals." It is, after all, a much cheaper policy to experiment with anti-tank guns than with tanks; the technical problems to be solved, whilst difficult, are much less so than that of tank-armour. The ultimate issue will undoubtedly be a heavy machine-gun comparing with that of to-day as the quick-firer compared with the breech-loader; a weapon in which the recoil will be so modified as to render it possible to use a very light tripod. Such a weapon will be a two-man load, and could be handled almost as easily as the present-day Lewis gun.* If it comes to a fire-fight the odds are heavily on the anti-tank gunner who can see his target clearly, and fire stationary, whilst himself almost invisible to the gunner on

* We could undoubtedly produce such a weapon *now*.

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the tank. And the student must take to heart Farragut's words: "The best protection against the enemy's fire is the fire of our own guns."*

The differing conditions of warfare by land and sea render it impossible to produce a tank truly equivalent to the " capital " ship.† The naval officer if asked to risk his battleships in cramped regions such as the Baltic, which involve handicaps upon movements analogous to those on land, very wisely declines to do so. The real equivalent on land to the " capital " ship is the " mixed division," which, made up of infantry, artillery, auxiliary units, and with an allowance of aircraft and tanks, forms in reality a " team," the composition of which can be varied in accordance with ground, but which looks for success to the co-ordination of arms, whilst it compensates for relative slowness of movement by the sheer element of weight and power. Much which is written upon " mechanization " fails to realize the importance of team-work between heavy gun and anti-tank gun,‡ and to make allowance for the interaction of arms and its bearing upon the *engineering* aspect of the problem. Although it is sometimes possible to get higher speed with a bigger engine and a heavier vehicle, this does not affect the general principle that speed means the sacrifice of *weight*. Take *Repulse*, of 32,000 tons displacement, and compare her with *Royal Sovereign*, displacing only 25,750 tons. From the absolute standpoint *Repulse* is a bigger and heavier ship, but from the tactical standpoint she is a much lighter ship, for her superiority in speed (she is a battle-cruiser) is gained by great sacrifices in guns and armour. Applying this reasoning to the land, it is obvious that the power which we take to move a self-propelled gun attached to a rapidly moving cross-country " mechanized " unit, if applied to a gun meant to move with a relatively slow-marching column of infantry, will move a weapon greatly superior in weight and range.

Thus, in the near future, our self-propelled 18-pdr. is likely to come up against 4-in. or 5-in. guns—working hand in hand with anti-tank gunners. With this in mind, consider the plight of the " mechanized division " such as is protrayed by Colonel Fuller and other writers—pitted against the " mixed " division. Apparently, the theory is that the " mechanized division " can work to a flank, its guns can enfilade " a long line of guns," which cannot " refuse a flank or retire fighting. . . . Then tanks moving up by covered approaches will break the line centrally and will enfilade it in both directions." Confronted by this horrific " wision," Colonel Rowan Robinson can see nothing

* "The War has proved that an adequate provision of fire-power is the best antidote to heavy casualty lists." Major Brook, " Evolution of Artillery in the Great War," *R.A. Journal*, January, 1927.

† *Vide The 'Mechanization' of War*, by the present writer, for a more detailed comparison between tank and warship-design.

‡ Col. Rowan Robinson in *Artillery: To-day and To-morrow*, completely overlooks this point.

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for it but to crowd our entire army into tanks, mechanize field artillery and to use it in large groups under "control from the air."

Passing the practical difficulties in the way of controlling from the air what is, by hypothesis, a rapidly moving force on land at death-grips with an enemy, surely it is quicker and easier to move across the *chord of the arc* than around it? The commander of our "mixed" division, if competent, will be just as much alive to the danger of being outflanked and enfiladed as the commander of the "mechanized" division will be keen to do this. Unless, therefore, attacked simultaneously and frontally by a force of equal power he will have his patrols widely thrown on either flank, watchful and wary, fire-zones mapped out, part of his artillery ready to be transferred to the threatened flank, heavy guns ready to slam down a barrage so soon as tanks are reported; anti-tank gunners ready to be crowded on motor-lorries and rushed to occupy a fighting line.* What is likely to happen? The enfilading self-propelled guns must be either stationary or in motion. If in motion they sacrifice accuracy of fire, bumping and jolting, their shooting becomes little more than an advertisement that an attack is in progress. They and the tanks with them will come under fire from anti-tank guns, firing armour-piercing bullets, and an artillery fire of increasing intensity. On the other hand, the self-propelled guns may take up positions from which, firing stationary, they can cover the attack of the tanks. If they do this, how long will it be before they are "smothered" by the heavier metal which will be brought against them? What are the exact chances of tanks "charging" infantry armed with machine-guns capable of piercing their armour at 600 yards and at an angle of 45°? Isn't it likely to work out into a new edition of the French Cuirassiers at Sedan?

One must never forget that, in Napoleon's phrase, "one cannot manœuvre except around a fixed point." Unless there is a frontal attack sufficiently powerful to hold the "mixed" division to its ground, the advantage of "outflanking" is more apparent than real. An enemy on the alert can always change front in time to meet it. At Jutland, the British battle-cruisers actually performed an analogous manœuvre when they crossed the German T. Scheer extricated himself by his "turn all together." Yet the British fleet was vastly superior to the Germans in speed and gun-power. The naval manœuvre of "crossing the T" and of getting an enemy into the "cauldron," however, pre-supposes no loss in accuracy of fire with the vessels performing this manœuvre. The trouble on land is that the gun in movement, unless upon an absolutely billiard-table-like surface, sacrifices accuracy to an alarming extent. The tactics suggested thus actually work out into a thing reminiscent of the Indian stories of our boyhood, Comanches dashing around a wagon-

* Very possibly he would cover his flanks by minefields.

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lager, firing sheltered behind their galloping horses. Such attacks usually ended disastrously for those who made them.* That the "mixed division" can much more than hold its own when acting on the defensive needs, I think, no further demonstration: the real problem is: Can it protect itself while in movement? This is a matter upon which I write with some diffidence, for my views are in conflict with a very distinguished soldier for whose opinions I entertain profound respect. The theory is that the "mechanized" division will circle around the "mixed division," thrusting at its rear and flank-guards, and producing a state, at the very least, of "alarums and excursions" which will paralyse movement. The problem seems to me to be one very much of leadership. If the "mechanized" commander is a Ziethen and the "mixed" commander is a dud, these things could undoubtedly happen. But given good leadership the commander of the "mixed division," if aware that he is liable to be attacked, will not move in column of route but in a *bataillon carré* formation, with his baggage in the centre, his aircraft sweeping far overhead, screens of patrols thrown forward and on either flank. He will have given "battle-orders" as to what is to be done when tanks are reported, and everyone will be on the alert. The time required for his own guns and anti-tank guns to come into action would be measured in minutes, and it does not seem unreasonable to suggest that, with a protective screen sufficiently well arranged and far ahead, he should be able to secure these few minutes. Given highly trained, disciplined troops, the charging tank will then be met by a cyclone of fire.

The "mechanized division," at least of the type put forward, is gravely handicapped as compared with the old cavalry division, which could not alone live on the country but dismount its men for a "set-piece" attack. A point which has always puzzled me is how our "mechanization" enthusiasts propose to deal with *forts*.† Are they to fall like the walls of Jericho to a chorus of "scientific" declamation? Commonsense teaches that such points as bridges, tunnels, railway-junctions, etc., vulnerable to raids, will be fortified and, in all probability, girdled with mines. Is the "mechanized division" to charge these forts? If not, it must have infantry and be prepared to make a "set-piece" attack.

The combination of "mechanized" division with "mixed" division may be compared perhaps with that of destroyers and battle-

* Beatty was a very daring leader, but if he had handled his battle-cruisers at Jutland in the fashion some of our writers suggest for a "mechanized" unit on land, not a man would have escaped to tell the tale.

† It is suggested that infantry should be carried in "armoured" vehicles. If infantry need an armoured "Cook's Tour" to get to the fighting point, they won't be much good when they get there. Also, the plight of the infantry crowded like sardines in a vehicle which will be a magnet for every hostile gunner, just sufficiently "armoured" to ensure that a shell will burst with the maximum possible effect, will be far from enviable.

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ships. The true *rôle* of the "mechanized" division will be to "screen" the "mixed" divisions, *to exploit the opportunities created by these*, and if necessary to sacrifice themselves by desperate counter-attacks to extricate their own army from a dangerous situation.

In summing up, judging from what has happened at sea and in peace-industry, there seems to be no bright prospect that "mechanization" will reduce the size of armies, their cost, or the complexity of leadership. On the contrary, it is much more likely to increase all these things. The more highly industrialized a nation, the *greater* the percentage of its manhood it can put in the field, *e.g.*, France and Russia. The gun, rifle, machine-gun, etc., are all just as much machines as the tank: to gain *mobility* we must sacrifice *weight*, and it will always depend upon circumstances whether this sacrifice is justified. The menace from the air, and raids by mechanized forces, are likely to lead to a development of the system of ring-fortification, and this will be very expensive in men and guns. The principle of *concentration of strength* will affect the operative size of armies—no General Staff will be anxious to indulge in "side-shows"—the principle of *enforcement of a decision* will lead to "speeding up," for every government will be anxious to avoid a long-drawn out and indecisive struggle. It is unwise to accept the assertion that a conscript army cannot effectively use "mechanized" forces. Although war at sea is a highly technical process, the short-service conscript German seaman gunner was not, at Jutland, markedly inferior to his British long-service professional *confrère*. It is equally unwise to accept the conclusion that because France has, say, 600 miles of frontier to defend, she cannot produce a "mechanized" army on as great a scale as ourselves. On the contrary, the more France is exposed to attack, the greater the effort she is likely to make for her defence. The last war saw conscription of men to serve machines (rifles, guns, etc.); the next war will see conscription of women, children and old men to serve machines in munition factories, and conscription of even more men to serve machines in battle. In other words, should the British Empire be pitted in war on land against a power as formidable as was Germany, the call for national effort and national sacrifices will be even greater than in the last war, and it is hopeless to believe that such a struggle can be fought to a victorious end by our tiny regular army—even if fully "mechanized"—whilst the rest of the nation cheers them on to the slogan of "business—and pleasure—as usual."

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THE ERECTION OF A 150-ft. WIRELESS MAST.

By No. 9 Field Company, Q.V.O. Madras Sappers and Miners.

The mast to be erected consisted of six sections of steel piping, internal diameter 4 in. and external diameter 4½ in., weighing 10¼ lb. per foot run. The lengths of the sections varied so that the joints, which were of the flanged type, should coincide with the points of contraflexure in the mast when strained by a wind. It was to be guyed at 50-ft. intervals, by three 1½-in. S.W. guys at each point. The designer had apparently made no allowances for stresses in erecting, as it was proposed that a scaffolding should be put up 150 ft. high from which the mast could be erected. A contractor was found who, after making all the necessary holdfasts, fixing the foundations and making up the guys, considered it his best policy to disappear. No contractor would undertake completing the work, and finally it was given to No. 9 Field Company, Q.V.O. Madras Sappers and Miners.

The flimsy nature of the mast at once ruled out any normal method of erection. The general principle worked on was to place the top section vertically on the ground, then to attach a tackle to the lower end and lift it, keeping it vertical by means of guys, until the next section could be slipped underneath and bolted on, repeating the process till the mast was complete.

The first photograph shows the apparatus used. The two sheers were erected facing each other so that the centre point of the quadrilateral formed by their feet was 18 in. to one side of the base section, which had already been set in concrete with 10 ft. projecting above ground level. The long sheers on the left were duplicated in order to give the necessary strength. The photograph was taken during the second lift, the length of mast being lifted is 63 ft., and the next section to be added (26 ft. long) can be seen lying on the ground between the sheers. The top guys with their insulators and the halyards for erecting the aerials can be seen. Between the crutches of the sheers are four temporary guys, whilst the clamp for the 100-ft. height guys can be seen between the two bamboo stagings. As these points passed the top of the long sheers, the temporary guys were cast off and the permanent guys fixed. The second photograph shows the next section being bolted on, and the wire guys which have just been attached to the 100-ft point. To provide a suitable hold for the lifting tackle, two sleepers were bolted together, one each side

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of the tube, the sleepers being shaped slightly so as to fit the tube. This provided a perfectly secure fastening for the tackles and did not slip for loads up to 2 tons. The lifting force was provided by a 10-cwt. winch working on a 3-3 tackle. (Photo 3.)

This force was transmitted to both ends of the sleepers bolted across the mast by means of a bridle. Between the bridle and the 3-3 tackle was a 5-ton tension meter. Photos 3 and 4 show an N.C.O. reading the meter, the two halves of the bridle emerging from the " single block bridle hand " and the two halves of the " reins " then passing through leading blocks on the sheer legs from where they pass over the top pulleys of the sheers and are made fast to the sleepers. This ensured an even pull on both ends of the sleepers and eliminated any tendency to twist the mast.

The party used on the work consisted of 2 B.O's., 1 B.N.C.O., 2 I.O's. and 100 I.O.R's., who were distributed as under :—

9 Guy parties each ...	1 N.C.O.,	3 Sappers	36
Temporary foot rope men		8 ,,	8
Winch party	1 N.C.O.,	3 ,,	4
Tension Meter	1 ,,		1
Bolting-up party ...	1 ,,	4 Sappers	5
2 Plumb-bob parties each	1 ,,	3 ,,	8
Stores	1 ,,	2 ,,	3
Spare men	—	—	26

The spare men were essential for carrying up sections of mast, holding temporary guys, etc., as none of the other parties could leave its post. The plumb-bob parties each worked with a plumb-bob, their lines of sight meeting at right-angles at the mast. The N.C.O. in charge compared the line of the mast with the plumb-bob. Each plumb-bob consisted of a bamboo tripod and a large stone suspended by a piece of thin brass wire into a bucket of water, which prevented it from swinging about in the wind. The N.C.O. would then order his sappers to give signals with different coloured flags, indicating the positions of the top of the mast, the point of attachment of the middle guys, and that of the bottom guys with reference to the vertical. The whippy nature of the mast made these precautions necessary.

The procedure of lifting was as follows :—

(*a*) Sleepers bolted across the bottom of the mast and tackles fixed and the load taken by the winch.

(*b*) Plumb-bob parties start signalling. From their signals, the officer in charge of the work adjusted the top guys, and the second officer adjusted the intermediate guys until the mast was not more than 4 or 5 inches out of the vertical at any point. To correct the mast, guys were as far as possible slackened off (the officer specifying the amount) and never

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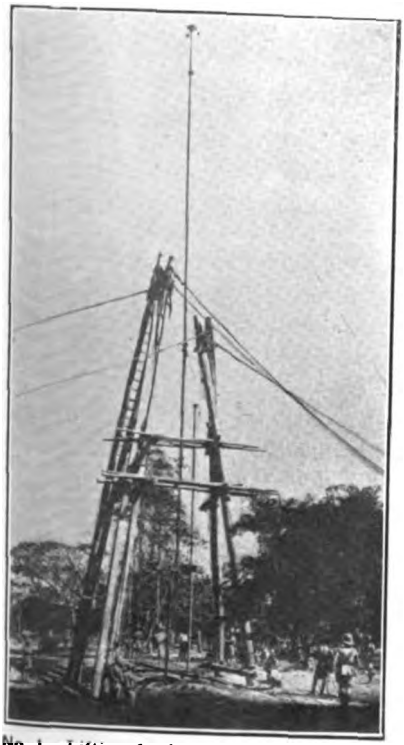
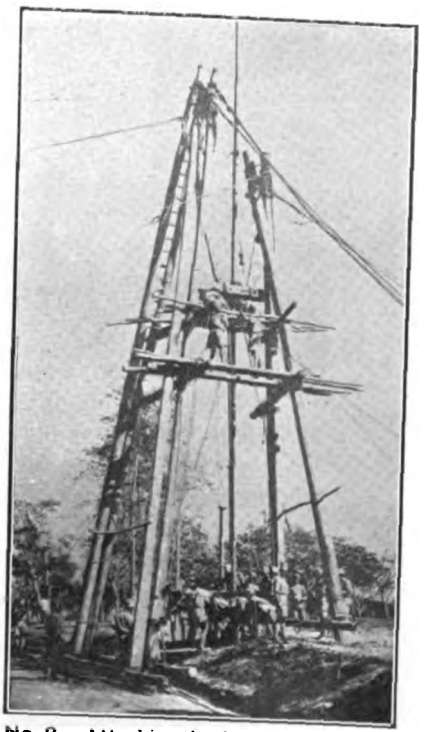
THE ERECTION OF A 150-FT. WIRELESS MAST.



No. 1.—Lifting 63 ft. of Mast. The next section to be attached is lying next to the base section.



No. 2.—Attaching the fourth section. The middle guys have been fixed. They will be pulled tight when clear of the sheers.

No. 3.—Winch and 1 in. S.W.R. 3-3 Tackle. The centre of the Bridle is seen on the left. An N.C.O. is seen reading the tension meter. The Sappers behind him are holding a foot rope.

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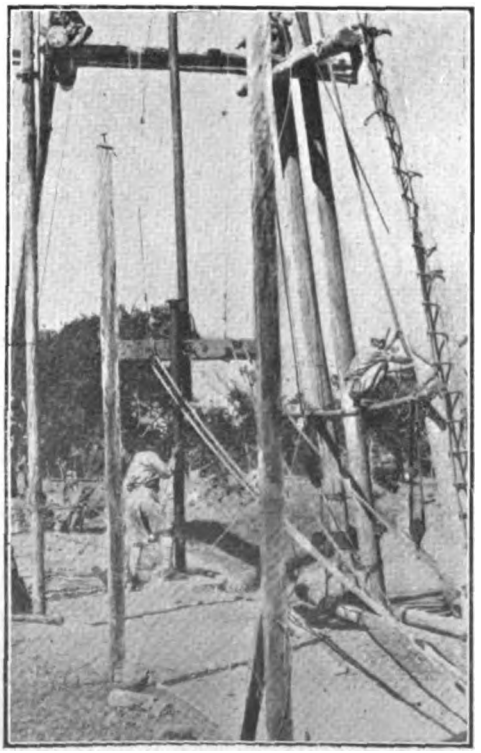
No. 4.—Lifting tackles showing bridle.



No 5.—The final lift; traversing and twisting tackles fixed. *Note.*—Rope tackle on right used for lifting single sections.

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tightened. The guys themselves were turned round a temporary picket holdfast placed as near the permanent holdfast as possible. The Indian officers watched that N.C.O's. carried out orders exactly.

(*c*) The officer in charge orders the winch to take in. As the mast rises, the N.C.O. on the tension meter calls out the readings, and the plumb-bob men signal the actions of the mast. When the tension meter registered 1¾ tons the winch was stopped and the mast trued up again. Then, if the meter still registered over 1¼ tons, the tier of the guys which appeared tightest were loosened 3 in., which usually brought the load down by 10 cwt. It was found impossible to raise the mast more than about 8 in. before the load became excessive.

(*d*) When the mast had been lifted about 2 ins. higher above ground level than the length of the next section the latter was erected underneath and bolted to the mast securely.

(*e*) The mast was then lowered about 2 in. on to packing, and the sleeper grip taken off and attached to the bottom again, ready for the next lift. The longest section of pipe put in was 29 ft. 6 in. which necessitated a clear lift of 30 ft.

The final lift and traverse of 18 ins. was effected by paying out the guys unequally. Photo 5 shows the mast during the last lift, with a tackle on each end of the sleeper grip, by which the bottom of the mast was pulled over the last 3 or 4 inches, and twisted so as to make the bolt holes in the flanges correspond exactly. The guys were finally made fast to their holdfasts and adjusted. The guys on the whole gave less trouble than was expected; they seldom had a pull of more than 100 lb. in them, and it was found quite easy to pass the insulators round temporary holdfasts.

The actual dead weight of the mast and guys was just over 15 cwt., and it was roughly estimated that the effect of the tension in the guys would increase this by a ton. The tackles and sheers, etc., were calculated to take a load of 2 tons. The tension meter was of great assistance to the officer in charge as it prevented the possibility of over-straining the tackles by taking in more on the winch than the guys could allow.

The whole work, including transporting all stores from Bangalore to Hebbal, a distance of 5 miles, and returning again, occupied exactly one week. The work was of a great instructional value in that materials were being used to their safe limit and that the success of the work depended on every man carrying out his work exactly—two points which are not obtained in any ordinary field work course.

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WORKS SUPERVISION AT HOME.

By CAPT. J. C. P. TOSH, M.C., R.E.

THIS article is written as a result of experience of the Reconstruction Scheme at Catterick Camp during the last few years and it is intended mainly to help those who find themselves in charge of such work with little previous experience. The work is now nearly completed, and whatever opinion there may be as to the success of the Scheme, there is no doubt that the supervision of work on such a large scale has demonstrated many important points which are not so clearly perceptible amidst the mass of routine work and paper included in the work of the average Division Officer. The important thing to realize from the start is that the Supervising Officer, or D.O., will find that he has more to do than he can manage. He must economize his time by looking ahead; if he waits for difficulties to turn up, he will be rushed off his feet with minor troubles and lose his power of intelligent forethought, with drastic results. This sounds like a platitude, but it is very easy for a D O. coming to a new job, faced with an orderly array of plans, specifications and bills, to imagine that there is nothing more for him to do than keep his eyes open and watch the job growing up around him. There is no greater delusion. It is of the utmost importance that the D.O. and a small staff should be on the ground several weeks before the contractor arrives with his peck of troubles. What preliminary work can be done must naturally vary with circumstances, but as a guide, the following points might require attention :—

(i) Floor levels of buildings. Get the corner pegs of buildings roughly put in and fix on floor level and decide if any break in the buildings is desirable on a sloping site. A slight alteration in the position of the building may be economical. Decide on the minimum depth of foundations, if this has not already been done. You will possibly have to go deeper in places, but you must start off with a reasonably good shot or you will have a lot of trouble later.

(ii) Lay-out of drains and roads. These are probably already on the plans, but you must check them, as they are seldom bullet-proof unless done by the man who is going to supervise the work. The drainage of flat sites requires particular attention and also the question of cross drainage to roads.

(iii) Study the contract documents. These frequently call for special agreements with the contractor as regards main-

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tenance of existing roads, supply of electricity and water from W.D. sources. Make up your own mind as to what is fair and get out draft agreements and maps where necessary ready to present to the contractor. He may disagree and the draft may have to be amended, but you will have the great advantage of knowing your own mind on the matters and much time will be saved.

You may also find that certain conditions of the contract are not very suitable for the locality and may be able to get these altered before they cause friction. For example, your specifications may state the foundation concrete is to be—1 : 3 : 7—you find the local resources consist of good pit run gravel, containing approximately the right proportion of sand and stone which is normally used in the district for mass concrete. It would obviously be carrying the letter of the law too far to attempt to insist on the contractor's screening and re-grading all his gravel, and the specification should be altered accordingly to one part cement to eight parts pit run gravel, which is about the corresponding mix.

It is also possible that some details of design are not at all suited to the locality and require alteration. For example, ground floors laid on fillets bedded direct on the concrete seal are commonly used in economical designs, but in some instances, notably in the case of sloping sites, the fill underneath them may be considerable, and it is necessary to work out the economical limit of filling above which ordinary joisted floors become more economical. On some sites where the soil is a strong clay, any depth of filling is impossible, and, further, all seals must have hard core under them, which is normally omitted from our specifications. These things are simple enough if instructions are given in good time, but cause a lot of trouble if left till the brick-laying begins.

It is also well to have a look at the specifications and compare them with local resources as regards such universal materials as bricks, sand, stone, gravel, etc., and decide what standard you are going to adopt. In many cases you will find that materials strictly in accordance with the specification are not available, and it is useless to try to insist on the contractor importing large quantities of common materials from other parts of England. If you have time, have a glance through the items for which Prime Cost sums are allowed and get some idea of the class of article you think suitable. It is hard to think straight later on, when you are immersed in details of all kinds. For example, in superior buildings such as officers' messes, P.C. sums are generally allowed for the grates and mantelpieces. If left

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to himself, the contractor will probably send four or five drawings of such articles, with a request for an early decision as he is nearly ready for them, possibly you are not much impressed by any of them and cannot judge from the drawings what they will really look like, but time presses and you finally plump for the least objectionable. It is much better to be able to consider the matter quietly beforehand and tell the contractor the type you consider most suitable, and ask him to get quotations.

The question of plans is a difficult one ; they will normally be on a scale of eight feet to the inch, and in these days of strict economy in space, a few inches may defeat you completely. You should put your draughtsman on to the more important plans at any rate, and get him to check such troublesome details as stairs, door clearances, etc., and prepare details as required. Sculleries are nearly always a difficulty and a detail plan showing position of sink, draining board and plate rack (with reference to the size of a plate) is nearly always necessary. The question of adapting the various standard cupboards to the plan also requires attention. See that the eaves in small houses do not prevent the upper floor casements from opening. The plans of special buildings, such as bakeries, special stores, hospitals, etc., require careful scrutiny ; even though approved by various departments they are apt to give rise to snags. Put yourself in the position of the baker, the butcher, the stretcher-bearer, the patient ; cut out to scale cardboard plans of trollies, handcarts and stretchers and see that they will go round corners and through doors. It is your job to make a real workable scheme, not to take refuge behind approved plans !

Other preliminary work may include the preparation of stores orders, drafting special contracts such as for heating, asphalte, fencing, etc., and preparation of colour schemes, external and internal. All these things can be, and frequently are, done during the contract, with the result that you have to rush them and are too worried with constant difficulties to look ahead ; a vicious circle is started from which you never emerge and life becomes one series of regrets that certain obvious mistakes were not foreseen in time.

We now pass to the time when the contractor arrives on the site. It is the universally accepted duty of the D.O. to secure economy, efficiency and compliance with the specifications. It is not, perhaps, so generally recognized that you must also work for punctuality and, above all things, peace. It must needs be that disputes occur and that many will have to go to higher authority, but every effort must be made to nip them in the bud. The bigger the contract, the more widespread is the competition for it, and consequently the finer cut will be the prices of the successful contractor. It follows that the contractor cannot be expected to go one inch beyond the conditions of his contract ; he cannot be called upon to do anything which is not clearly included in his bills, though they may be hinted

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at in the specification and, above all, he cannot be expected to solve unforeseen difficulties which may crop up. I mention this because frequently with small Part II Services a local contractor gets the job at his own price and goes out of his way to put it through satisfactorily. This must never be expected as a right.

It goes without saying that the contractor and his staff may be expected to have a life-long experience of the intricacies and tricks of the trade and the legal aspects of contracts. Moreover, in many cases his agent and staff worked together before ; he is free to employ or dismiss whoever he likes, and, generally, has few restrictions. You, as D.O., on the other hand may or may not have had much experience. You have many regulations to hold you down. Your staff is probably detailed by someone else and taken from you without appeal when occasion demands it. A contractor will frequently give a good foreman ten pounds a week and a house and perquisites to ensure keeping him as long as wanted, while the D.O. may have his best foreman of works detailed for foreign service at a critical period. You can seldom get rid of men you do not like, and you are not the final arbiter in case of dispute. A further word of pessimism: you must not look on the contract documents as if they were the Ten Commandments, as many of its clauses may be open to argument.

How then are you, with all these disadvantages, to keep your end up with the contractor? Firstly, by maintaining absolute fairness in your dealings.. It goes without saying that you should honour your written and spoken word, but you should also honour the impressions you have given, however much you regret it. If you have seen an operation going on for some time and made no remark, and later discover that it is not quite in accordance with the specification, you should not condemn it, having previously given the impression that it was satisfactory. Further, you must be fair to the sub-contractor. Officially, the sub-contractor is not supposed to come into contact with you at all, but in practice he must, to some extent. Beware of coming to a final agreement with the sub-contractor instead of with the contractor, as the latter may then claim to be relieved of responsibility; by all means, in case of difficulty, hear what the sub-contractor has to say and ask his advice if you like, but make the agreement with the contractor. Do not be harder on the sub-contractor's work than on the rest of the work ; it is very easy to be so because the sub-contract probably calls for the work to be done to the satisfaction of the W.D. and the contractor is generally ready to earn a good mark cheaply by bullying the sub-contractor to any extent. Keep to the same standard all round. I have purposely stressed this question of fair dealing, not because I have any fanatical views on the subject, but because after due experience I am convinced that it forms a far better qualification for supervising big works than any specialized training in the building trade or contract law can

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possibly give. You cannot expect to " beat the contractor at his own game," so to speak ; a real sense of fairness is seemingly absent from the commercial world, and the average contractor is quick to recognize and respect it and generally slow to take advantage of it.

The contractor, especially during the early part of the contract, will have many questions to ask, and it is well to bear it in mind that some of these may not be fair questions. He may ask for instructions as to how to carry out a job, the methods of doing it being his own responsibility. For example : an underground pit has to be constructed and asphalted in wet, and the contract, as it normally does, provides that the contractor is responsible for dealing with all water met in excavation. It is clearly his responsibility to keep the site dry by pumping or otherwise, while the asphalte is being applied and to produce a dry pit on completion. He may ask you for instructions and if you give them you take the responsibility for the success of the work. Such questions should be answered only in the form of giving advice with the proviso that the responsibility for success rests with him. Fair questions must be answered clearly and the temptation to talk round a thorny point resisted ; if you do not know the answer, you should say so and then proceed to find out as soon as possible. This attitude not only commands the respect of the contractor, but also frequently makes it possible to settle claims with him which might otherwise go to higher authority.

The importance of good relations between the D.O. and the contractor cannot be over-estimated, and these good relations must be founded on a sympathetic understanding of the contractor's difficulties. These difficulties arise chiefly in connection with :—

(*a*) Small scale drawings which require explanation and amplification—before the snags arise—not after.

(*b*) Supervision, when the work is scattered and varied as at Catterick. The contractor is frequently unaware of certain malpractices taking place and it is extremely beneficial to him to have such things put right before they have gone so far as to require expensive alterations.

(*c*) Alterations to plans which are frequently inevitable and are allowed for in the contract. They are nevertheless a source of much trouble and expense to the contractor, and the effect can be mollified to a certain extent by foresight on the part of the D.O., not only in foreseeing possible alterations but also by ordering them in groups to facilitate supervision, instead of piece-meal.

(*d*) Labour difficulties due to the more independent attitude of labour nowadays, which will be touched on later in the article.

(*e*) Supply of R.E. stores which may hold up the work, particularly in the case of such articles as cooking ranges which have to be built in.

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It is an excellent plan to hold conferences about once a fortnight between the contractor's agent, and his surveyor if he thinks fit, and the D.O. with his assistant D.O's. if any, and I.W., to talk over affairs in a friendly spirit. Of course, any decision reached must be reduced to writing. Controversial matters requiring a lot of investigation cannot be adequately dealt with and sudden decisions on such matters must be guarded against, but a vast amount of useful work can be done. The contractor can bring up future difficulties he anticipates, and can explain his programme and the priority he desires in R.E. stores. You can explain your difficulties and show the contractor what you are doing to help him. A great deal can be done by word of mouth which cannot be done in writing. As the contract nears completion, it is probably advisable to abandon the regular conference, as any point arising then requires immediate attention.

Before leaving the question of the dealings between the contractor and the D.O., a few remarks on the all-important question of claims are appropriate. In these days of keen competition many contractors look to their claims to give them a profit, and it is necessary to look at such claims sympathetically. It is a great advantage to get claims settled early, so that the financial situation is not obscured by them; they should never be shelved when they arise; hence again we see the necessity of keeping ahead of your work, so as to be able to deal with them as soon as they come to light. It is also a tremendous advantage for you to be able to deal with them yourself, for the following reasons: it accelerates a settlement, it is less trouble because the labour entailed in putting up a case to higher authority is very considerable, and it increases your influence over the contractor. Even if the claim is such that you cannot settle it, you should endeavour to agree with contractor, without prejudice, as to what the reasonable settlement should be, and send up your recommendations with the case. The first thing to consider is whether a claim is reasonable or not; reasonable claims are those arising from extra work necessarily performed, or from difficulties encountered which could not reasonably be expected when tendering; or they may arise from difficulties which have been quite inadvertently created by the supervising staff. Claims which cannot be considered at all are those arising from difficulties which the contractor should have allowed for in tendering and those due to extra work necessitated by his mistake or faulty workmanship. If extra work done inadvertently is clearly a benefit to the undertaking it should, if funds allow, be paid for as an extra. The settlement of claims does not always entail money; there are always small omissions by the contractor or departures from specifications which are not worth putting right, and these may be used to balance against small claims by the contractor Compromises generally should be avoided in settlements; either the claim is allowed and should be

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paid for in full, or it is not allowed and should be entirely rejected. To offer to pay a small proportion of an unreasonable claim encourages the contractor to go on claiming, and causes endless trouble. Measuring should not be regarded as a panacea in settling claims, when the amounts involved are small it saves expense and trouble to agree " star " prices, or, better still, balance them up against something else. So much depends on the relation between the contractor and the D.O.; if you have encouraged the contractor to chat amicably about his difficulties from the start and shown yourself sympathetic but just, claims will be few and simple to deal with. If the contractor regards you solely as the man who stands between him and his fortune, claims will be large, numerous, and acrimonious.

Now for a few remarks about the opposing armies. On our side we have surveyors, draughtsmen, clerks of works. In very small jobs, of course, these three may be one, in the person of the M.F.W., and you obtain what you seldom get otherwise—perfect co-operation of the three departments. Though the functions of the three groups appear superficially to be distinct, in actual fact they all overlap on the question of details of design and friction may develop as a result. Smooth working can only be assured by the adequate supervision of their work, not to cramp their initiative but to give them just what guidance they need to obtain uniformity of effort and to ensure that no avoidable obstacles are left in the path of any of them. The secret of developing intelligent initiative is to keep everybody informed of what is going on, and to avoid water-tight compartments above all things.

The clerk of works is one of the most important units of your army; a really good man is worth his weight in gold; an inefficient man is worse than nobody at all. We cannot consider the clerk of works without at the same time looking at his opposite number, the builder's foreman. The latter is almost always a man with life-long experience of his job and may be of two types—the old foreman who has worked for years for his firm and has its reputation at heart, and owes his position mainly to his good work; this, I believe to be a somewhat rare type and is only to be found with the better-class firms; or he may be of the go-ahead type who generally flits from firm to firm, and builds his reputation on getting the work done fast and cheap. This latter type is by far the more common and the more difficult to deal with. It follows that a successful clerk of works must be on the top of the builders' foremen; he must have a better knowledge of the building trade; he must have more determination and he should be a man of better education. The clerk of works may be either a military or civilian. Hard though it may seem to say so, in the light of recent experience, it appears that the civilian is much more suitable for the job than the military man. The latter usually lacks in the essential foundations of wide practical experience in the building trade, and this puts him at once in a position of in-

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feriority to the contractor's foreman, unless he has had more than the normal experience of new services and good trade qualifications to start with. On normal maintenance jobs, a military foreman of works puts in too much time in office work to get the full benefit of practical experience. He has the further great disadvantage of being liable to be posted elsewhere at any time, a practice which results in considerable financial gain to the contractor and untold worry to the supervising officer. On the other hand, work of this nature is a first-rate experience for a young M.F.W., and for that reason their appointment should not be discouraged, but they should be so employed that their work can be easily taken over by someone else; generally, they require more supervision than a good civilian. A civilian clerk of works is naturally a somewhat unknown factor and considerable discretion is required in taking one on; he may be an ex-M.F.W., or he may have purely civilian experience. He should have unquestionable character references; he should not be too old—generally fifty is about the limit; he should be of superior education, possess personality and not be super-self-confident. In other words, if he is to be a success you must like the look of him. Technically, he will probably be able to produce references attributing to him a detailed knowledge of every kind of building work, but be sure he can use a level. That is about as far as you can go in testing an applicant, and at a big job where several clerks of works are employed, you are sure to get a mixed team; the first essential is to get to know their characteristics and capabilities, and to post them according to what you know of the various builder's foremen.

In your dealings with them, and this applies to both clasess, remember that they have to work under certain peculiar disadvantages; the military man has his military duties and drawbacks, and a civilian suffers from the lowness of his pay. Probably he is getting about half the pay of the contractor's foreman, and this makes his life more difficult than might appear, if local society is somewhat restricted. It is, therefore, essential to do all you can to increase their prestige and generally to make things easier for them. Give as many instructions to the contractor's foreman as possible through your clerk of works and insist on his instructions being carried out. Ask his advice on how to solve various problems and if you do not like his proposals explain exactly why. Do not go round the work and criticize without him, or you may find yourself condemning some harmless pet theory of his about minor details; "the best is often the enemy of the good," and it is well to admit the existence of more than one reasonable method of doing things. Of course, obvious mistakes and malpractices should be stopped at any time, but that is a different matter. Let him know that you expect him to know everything that happens in his area and if you can see anything going amiss, ask him why he has not spotted it. Do not keep asking him for written reports, and above all, let him know exactly where

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he stands. The question of how much you can leave to him depends entirely on the man; for his good and yours you should trust him to his full capability. A difficult position arises when your clerk of works makes a decision which you do not wish to uphold; cancel it if you must, but remember the harm you thereby do to your man's position, and explain your reasons to him and the contractor; if the latter has done work in consequence of the decision before you cancelled it, he must be paid for it. Should a clerk of works be given to making unauthorized decisions, or even to be too hostile to the contractor, the situation may be improved by giving him more work to do. Some can only work satisfactorily when working at full pressure. The main point is that you cannot expect to get exactly the men you want; you must work them as a team in the positions for which they are best suited and your control must be elastic under the broad standards of quality and workmanship which you consider suitable. It should be impressed on all clerks of works that their job is to prevent bad work, rather than to condemn it when done. They should, of course, receive early copies of deviation drawings and orders and see that they are not overlooked by the contractor; in other words, they are to help the contractor, not to fight him. In particular, they must be tactful in dealing with the contractor's men, owing to the more independent attitude of labour. The commonest complaint of the contractor against the clerk of works is that he interferes with the men, and it is a most difficult complaint to deal with. In theory, the clerk of works should act solely through the builder's foreman; in practice, this is impossible on scattered works at any rate; his conduct should be a mean between the two extremes—he should deal with the general foreman, sub-foreman or charge-hands, wherever possible, and with the men only as a last resort, when things are going irrevocably badly and no foreman is present. A clerk of works who has recently been a builder's foreman is particularly useful by reason of his inside knowledge, but also is specially apt to deal with the men direct. It is a very difficult question and apt to give rise to serious trouble but, like many other things, it is more often the occasion than the cause of dispute, and if the clerk of works has established helpful relations with the builder's foreman the latter is unlikely to raise trouble on this score.

The thorny question of how much work one clerk of works can supervise has no answer; there is no standard either in money or area, or extent of works by which the staff required can be fixed; comparisons between works in different stations are valueless, unless conditions are precisely the same, and among these conditions is the efficiency or otherwise of the contractor; this much only can be said —an officer can hardly supervise efficiently the work of more than four clerks of works, and it is generally better to keep to this figure, at the expense of working the men rather hard, in preference to employing more, unless an additional officer is available.

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Another important duty of the D.O. is to keep the financial situation clear and up-to-date, in order to avoid running short of money on the one hand, or having an unwanted surplus on the other which might have been usefully expended in the work. Uncertainty in regard to the financial situation is a constant source of anxiety and sometimes results in economies being needlessly carried beyond the limit of efficiency. Assuming a good estimate to start off with, the probable causes of discrepancies are, firstly provisional work, secondly extras, and thirdly claims. Provisional work normally comprises roads, paths, drains, water supply and work below damp-proof courses, and a roughly estimated amount for all of these is allowed in the bills, subject, of course, to final measurement. There is bound to be some uncertainty about it, but the situation can be usefully improved by the early preparation of accurate drawings for external services worked out on the ground; such drawings not only enable a closer estimate to be made, but they prevent mistakes in execution. Alterations to the under-building, such as are entailed, for example, by the substitution of hollow for solid ground floors, should be decided early and a liability worked out.

With regard to extras, the only point to be emphasized is that they must, however small, be covered by proper priced deviation orders and the liabilities recorded. It is extraordinarily easy to neglect this procedure, especially where a number of small alterations are required, and particularly where instructions are given by clerks of works. Most contracts lay down that the contractor must claim within a specified short period for any work done by him without an order; in practice, this is a dead letter. All you can do is to insist on day-work sheets being sent in in reasonable time for checking—they often give a useful indication of extra work which should be covered by an order and measured.

Regarding claims, the importance of early settlement has already been urged. It is sometimes expedient to keep a definite reserve in hand to deal with possible claims, and if this is done, cut and dried schemes for spending that money at the very end of the contract should be prepared so that if the claims fail to materialize, the money can still be usefully expended.

The close control of finance if practised from the outset is not a laborious business and of first importance in economical administration.

In conclusion, it may perhaps be said that some remarks on technical difficulties and experience would have formed a more valuable contribution than the foregoing article on administration, but I maintain that this is not so. A sound system of administration should give a D.O. time to find out the technical details he requires, to use the experience of others, and, finally, to season the information he gets with the salt of commonsense before translating it into practice.

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JOTTINGS FROM A FIELD COMPANY ON MANŒUVRES.

By "GEEKAY."

ALTHOUGH the following useful and instructive lessons were learnt by this Field Company on Manœuvres last year, it cannot be pretended that there is anything very novel in them for many officers. Yet to some they may be new, and to others they may be of value in promoting discussion. This, then, is the excuse for these notes.

1. INTER-COMMUNICATION.

This proved a great difficulty at first. A Company, especially when in a Brigade Group, is bound to be in several detachments. For instance, in an approach march with an Infantry Brigade, there would certainly be (*a*) the O.C. with Brigade H.Q., (*b*) a reconnaissance party with the vanguard, (*c*) the main body, (*d*) "B" echelon first-line transport; probably also (*e*) an advanced section with the main guard. In attack, defence, and especially in a retirement, detachments are practically inevitable, while the distances between them may be considerable.

Though means of inter-communication, viz., motor and pedal cycles, are provided within the Company, it is felt that they should only be used for short distances or on particularly important occasions and that, as far as possible, the services provided by the Royal Corps of Signals should be utilized. To enable this to be done, the organization must approximate to the system of the Royal Signals and facilitate the establishment of report centres.

It was accordingly arranged, in conjunction with Signals, that each sub-unit should be prepared to find a report centre, which was given a code name, and that when the sub-unit was detached, it should keep its report centre in touch with a Battalion or Artillery Brigade H.Q., and use, as far as possible, the Signal Service it found there. It was to keep the cyclist orderlies normally for communication from the report centre downwards, and only exceptionally upwards. The organization tried on this occasion was:—

Report Centre.	*Coy. H.Q.*	*Each Half-Coy.*	*Each Section.*
Composition.....	O.C. 1 clerk 1 motor-cyclist 1 orderly Corporal	1 officer or N.C.O. 2 cyclist orderlies	1 N.C.O. 1 cyclist orderly
Code names ...	FINE	FINER FINEL	FINEA FINEB FINEC FINED

NOTE:—The Half Company and Section Report Centres were alternative. For instance, either the Left Half-Company *or* Nos. 3 and 4 Sections, would establish Report Centres according to circumstances.

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Instruction was given in writing messages and in using the envelopes in compliance with Signal procedure.

Unfortunately, the system was not fully tested, but from the few occasions which did arise it was evident that it would be of great value as soon as it became an established routine not only in the Field Company, but in the Signals and other troops whose co-operation is necessary. Mechanization, when it comes, involving as it will greater dispersion, will make some such system more imperative.

2. Messing.

Another difficulty which was due to the inevitable detachments was that of feeding the men, particularly the provision of a hot evening meal. It is most unsatisfactory to rely on a Battalion to provide food for an R.E. detachment; with the best will in the world there are many difficulties, and in practice it is essential to rely on one's own resources. The hay-box appeared to be the solution here. On manœuvres, when all too little work requiring R.E. to use tools is met with, there is room for a hay-box suitable for one section in the L.G.S. wagon which accompanies each section. If a section appears likely to be detached during the day, the hay-box can be filled with dinner at breakfast time. If the detachment is made at a time when the cooker is not up, the hay-box belonging to another section can be filled as soon as the cooker comes up, and sent to the detached section on the greatcoat lorry when it arrives.

3. Map-Reading.

The need for plenty of practical map-reading instruction was amply demonstrated. Though N.C.O.s and men may have passed the map-reading tests for the various certificates of education, the map-reading on operations was often at fault. Even young sappers who happen to be "cast" for the duty of cyclist orderly must be at home on the map. Therefore, map-reading instruction must be thorough and practical throughout the Company.

4. Clerk's Duties.

Do we give our clerks sufficient instruction in the duties they would have to perform in the field, *e.g.*, writing orders and messages from dictation, filing messages and field correspondence? Manœuvres provide an excellent opportunity for this. The clerk should also be good at map-reading, as he will prove of great assistance in checking map co-ordinates, etc. Incidentally, if officers practised dictation to clerks in their own offices more, they would find it a method of gaining increased clearness of thought and expression which would repay them well in oral and written examinations.

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5. AMMONAL.

Occasions arose when it was necessary (on paper) to crater roads. It was assumed that ammonal would be available from civilian sources —the operations were supposed to be in friendly country—some eight hours after it was demanded. This, however, proved too much for the umpires, who disallowed its use, as no reference to how it would be carried or supplied in war was made in any military book. Considering the unique value of ammonal, and that it is now ten years since the end of the Great War, in which it was so largely used, the decision seemed somewhat hard.

6. NOTICES ON DEMOLITIONS AND WORK DONE.

These, drawn up in the form laid down in *Training and Manœuvre Regulations*, added tremendously to the interest of the unit in the operations. They also provided very useful instruction for all concerned. It is suggested, however, that they require very careful umpiring, and that the forms might be issued in pads, so that three copies might be taken at a time with carbon paper; one copy to be put up at the site of the work, one copy for the umpire staff, and one copy for the Company commander to check over later for instructional purposes. In addition, the space allotted for the umpire's signature might be reduced and the printing re-arranged so as to give more room for sketches and details of the job.

As said before, careful umpiring is important. This is evidenced by the tendency of columns of All Arms to advance, often without a R.E. reconnaissance party well forward, and even more often without any R.E. working party further forward than the tail of the main body. An occasional tree felled across the road would bring the lesson home in a remarkable manner. Could not this be arranged?

7. MECHANIZATION.

By a fortunate chance it was found possible to hire privately two 14-cwt. Bean drop-sided lorries for the four days of the final manœuvres. The underlying idea was to see how even a small amount of mechanization might improve the efficiency of a Field Company, both from the point of view of capacity for work and of administration. The result, though the operations did not provide much of a test for the experiment, far exceeded the anticipation. Each lorry could take a section (peace strength) and enough tools for the job in view. It could travel up to 40 miles an hour on roads, and proved most reliable even though the drivers, who were found from the unit, were fairly inexperienced in lorry driving.

The use of these lorries in facilitating work was well shown on one occasion, when the Company was marching at the tail of a Brigade Group advancing. Within half an hour of the O.C. receiving, from the Brigadier at the head of the main body, the order to block against

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armoured cars the side roads opening on to the route, one section had reached the advanced guard and begun blocking the side roads. The lorry dropped detachments for the work at each point, and picked them up later. In this way it again soon caught up the main guard and was in a position to block roads as soon as the latter reached them.

On another occasion, reconnaissances for erecting a medium bridge over a river on a front of 2½ miles were required. By means of the lorry, which carried sufficient personnel and bicycles to make four reconnaissance parties, the reconnaissances were made, and the parties back at the Infantry Brigade H.Q., with complete reports within 2½ hours from the time they left that H.Q., which was four miles from the river at the nearest point, and 13 miles from the Company when the order to make the reconnaissances was given.

Again, an Infantry Brigade which was to have been embussed would have had two sections R.E. in M.T. up with it to clear roads blocking its advance and to protect its isolated flank as it worked forward " into the blue " to forestall the enemy on a " key " position.

These instances appear sufficiently convincing, though fate prevented the fulfilment of sensational dreams, such as using the M.T. to forestall, with an anti-tank minefield, a tank attack reported by air as being imminent, or surprising the enemy by constructing rapidly, with men unwearied by marching, a medium bridge at a considerable distance from where the enemy had located the Bridging Train.

On the administrative side, circumstances prevented the lorries from getting much scope, but how invaluable they would have proved in supplying food, greatcoats, bivouacs, etc., to, and replacing expended explosives with detached sections could easily be imagined after our experiences in the previous minor operations. As it was, they returned the Company quietly and comfortably to camp, 17 miles from its position at the " cease fire," in less than five hours, the men having all had a meal on the way.

The expenditure on the two lorries, apart from hire, which included the services of a civilian fitter to get our inexperience out of possible difficulties, amounted to £9 5s. 3d., but of this, £6 was due to arranging insurance against third party risks. This had to be done at very short notice, and surprising difficulties were raised by the insurance companies. A far cheaper rate could almost certainly have been obtained if the insurance had been effected earlier. The lorries between them covered 500 miles in the four days, and used 40 gallons of petrol.

To say that the lorries provided an interesting experiment is to say little—they turned what would have been a prosaic and rather wearisome four days into an intensely interesting, thrilling and by no means uncomfortable climax to our collective training.

We in this unit have no lingering doubts as to the desirability of mechanization as far as a Field Company, R.E., is concerned.

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THE USE OF POWER TOOLS IN A FIELD COMPANY, R.E.

By LIEUTENANT L. T. GROVE, R.E.

IT has long been suggested that more use should be made of power tools in a Field Company, and the subject is an interesting one, though it is easy to exaggerate the possibilities of the use of power in the forward areas. At one time, suggestions were made that there should be a kind of mechanical elephant with each section, that should be able to do such things as pile driving, concrete mixing, excavating and other duties, but it is now generally agreed that a combination machine of this type would be very unsatisfactory.

A clear line should be drawn between the work that a Field Company may have to do at a moment's notice and the more deliberate work for which there will be time to send up special appliances from R.E. Parks. Pile drivers, concrete mixers and excavating machines all fall under the latter heading, and although R.E. units should be trained in their use, there can be no excuse for attempting to carry such plant as part of the equipment of a field unit. Their place is in the R.E. Parks, and they can then be sent up when required.

There are, however, many applications of the use of power which are of the greatest value to a field unit for work which they may have to carry out immediately, without waiting for tools or equipment to be sent up to them. The most obvious of these are the use of a compressor plant and a winding gear driven from a lorry engine; the latter can be used in combination with a sheer legs mounted on the rear of the lorry. Both these appliances have been used by the 17th (Field) Company during training in 1928, and a brief account of the work which they can carry out may be of interest.

COMPRESSOR PLANT.

Description of Plant.—In the spring of 1928, the 17th (Field) Company were sent a Reavell portable air-compressor for trial with various types of pneumatic tools. This machine is almost precisely similar to those used for road-breaking on a large scale, such as may often be seen in London or elsewhere, the only modifications being that pneumatic tyres and a stronger draw-bar have been fitted. The machine is thus able to be towed, across country if necessary, by a six-wheeled lorry. To give a detailed description of its mechanism is quite outside the scope of this article. It is sufficient to say that

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it consists of a petrol engine direct-coupled to the air-compressor. Besides the ordinary ball type governor there is an automatic cut-out which regulates the air pressure between 75 and 100 lb. per sq. inch. Thus, once the machine is started, practically no supervision is required, and it is quite unnecessary to carry a special mechanic to look after it. Very little maintenance work is required either, and as the engine runs on grade III petrol similar to that used by the company M.T., there is no difficulty about fuel supply in the field.

Tools.—Three types of pneumatic tools have so far been tried :—

(1) *Concrete Breaker.*—This is the tool normally used for breaking up a hard road surface. The body of the tool consists of a barrel, inside which works a piston driven by compressed air and delivering a series of hammer blows to a steel pick about two feet long. It is a heavy tool, weighing about 70 lb., and for that reason its main uses are confined to breaking up horizontal surfaces such as roads, concrete floors, etc., where the operator can put his full weight on the handle. It is therefore especially useful for such purposes as digging a trench across a road to form an armoured car obstacle; digging down through the metalling of a road to place a mined charge for blowing craters or to get at the crown of a bridge; digging out girders which have been set in concrete, etc.

(2) *Pneumatic Pick.*—This is a smaller tool working on the same principle as (1). Its weight is only 16 lb., so that it can be worked one-handed if necessary, and is generally used against walls, abutments or piers, and for getting into awkward corners which the larger tool cannot reach. Naturally, it has not the same shattering power as the concrete breaker, but it is quite effective for cutting into brickwork or soft masonry.

(3) *Pneumatic Drill.*—This is a tool similar in size to (2), but works on a rather different principle, combining both "hit" and "twist." With each stroke of the piston, the shank of the drill rotates, thus producing the effect of a hammer drill. It can be used against rock, concrete or brickwork, and produces a bore hole 1½ inches in diameter, at an average speed (in concrete) of two feet per minute. The rate of working in other hard substances does not vary much, but the tool is useless in a soft or sticky material, such as wet chalk or clay. The value of this where a cutting charge is required for a hasty demolition is considerable, as it enables a row of bore holes two or three feet deep to be cut in a very short time. These can then be filled with any explosive made up in a suitable form, such as dynamite sticks, tubes of ammonal, or even a tin of G.C. primers, and the whole charge is very quickly laid and very economical in explosives. In this connection it might be worth considering the supply in stick form of a proportion of the wet G.C. carried by a Field Company.

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Results of tests.—In order to obtain a somewhat clearer idea of the possibilities of such an air-compressor in the field, a number of tests have been carried out with a view to estimating the time saved as compared with the ordinary methods. The results of these tests are tabulated below :—

Nature of task.	*Men employed by each method.*	*Time taken, using compressor and pneumatic tools.*	*Time, using picks, shovels, hammers, chisels, etc.*
1. Digging a trench 2 feet wide and 13 feet long in a first class tar macadam road.	6	35 minutes per foot deep.	1½ hours per foot deep.
2. Cutting a hole 9″ x 12″ in ordinary concrete.	2	10″ in 17 minutes.	3″ in 25 minutes.
3. Ditto in brickwork.	2	9″ in 15 minutes.	9″ in 75 minutes.
4. 1½″ borehole in concrete.	1	2 feet per minute.	—
5. Sinking a hole 1′ x 1′ in the middle of a macadam road, suitable for a mined charge, and for cratering.	2	15 minutes per foot down to a depth of 5 feet.	—

These tests were selected as typical of the sort of work which a Field Company might be called upon to do at a moment's notice in mobile warfare. 1. provides an effective armoured car obstacle in the sort of country where material for making road blocks is scarce. 2., 3. and 4. are suitable methods of laying a charge for the hasty demolition of piers, abutments or retaining walls, as they enable a big effect to be produced with quite a small charge. 5. is perhaps the quickest method we have at present of laying the charge for a road crater. It will be seen from this comparison that the rate of working, using the compressor plant, is about three to five times that obtained by ordinary methods, besides which, some of the results achieved are practically impossible without special tools. Experiments are also being carried out with a type of three-pronged fork, adapted for use with the concrete breaker, for digging in ordinary soil with a view to assisting rapid excavation in the forward areas. So far, not sufficient trials have been made to form any definite conclusions on this subject.

Besides these tests, an actual demolition of a masonry pier was carried out. The pier was constructed with a 9″ brick retaining wall, filled with chalk and rubble, its dimensions being 12′ x 6′ x 8′ high. Thus, using the ordinary formula ($\frac{2}{3}$ BT²) for a cutting charge against masonry, 288 lb. of G.C. would have been required. By means of the pneumatic picks, two holes 9″ x 12″ were cut into the centre of the pier, 3′ from each end. Then, treating it as a mined charge, it was found that 5 lb. in each hole would be sufficient. As a precaution this charge was doubled, so that 20 lb. were actually used as against 288 lb. by the other method. The total time taken to place the charge, connect up, and tamp, was under 45 minutes. More-

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over, owing to defective F.I.D. only one charge actually went off, but this alone was sufficient to cut the whole pier right through, and produce a complete demolition.

The chief difficulty so far encountered has been presented by reinforced concrete. None of the standard pneumatic tools can cut through the steel reinforcement, and we have got to find a special tool for the purpose. An experimental type, in the form of a punch, has just been designed, but it has not yet been tried out. When a suitable tool has been found it will become an essential part of the equipment, owing to the particular suitability of concrete work for demolition in this manner.

Owing to the nature of the work it was, of course, impossible to carry out practical trials with the compressor plant on manœuvres. Cases were, however, continually arising where it would have been of the greatest value, and its use was assumed in dealing with the situation.

Such cases may be mentioned as armoured car obstacles, bridge demolitions, craters in fords, etc., which, with an armoured force in the field, are of primary importance and have to be carried out often at a moment's notice. Generally speaking, the experiences of the manœuvres combined with the results of the practical tests described have shown that a compressor plant would be of great value to a Field Company in mobile war, and more particularly so when armoured fighting vehicles are involved.

Winding Gear.

The present proposal is that the tool lorry in each section should be fitted with winding gear and sheers. The method of carrying the tool boxes and sheer legs can be gathered from the accompanying photographs. The winding gear is a standard fitting and forms part of the gear box. It is engaged by a special dog clutch and fitted with a band brake for paying out slowly, or holding the load. The winding drum is geared at 68 to 1, with the gear lever in first speed, and with the engine running at 1,000 revs./min. the lineal speed of the rope is 44 feet per minute. (This figure is an average; actually it is higher when the drum is full and lower when the drum is empty.) The drum carries 96 feet of 1¼" special extra flexible steel-wire rope.

The sheer legs are fixed to the rear of the lorry chassis, the top of the legs being 10½ feet above the ground and overhanging two feet beyond the tail of the lorry. The wire rope can be used for horizontal hauling, being guided out between rollers on the rear of the lorry, or it can be taken over a pulley on the top of the sheer legs. A special frame and sprags are provided. These are carried on the lorry and can be fixed in a few seconds. They serve the double purpose of anchoring the lorry and of supporting the main frame at the point of

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attachment of the sheer legs, so as not to transfer the vertical stresses through the axle springs on to the ground. These sprags can be seen in use under the sheer legs in photograph No. 2.

The winding gear in conjunction with the sheer legs can be used in three ways, to suit different purposes :—

(1) The sheers can be used without sprags for lifting and carrying loads up to 15 cwt. Over this weight the front wheels of the lorry then tend to come off the ground, the whole chassis pivoting about the rear axle. With this load the frame is stressed up to eight tons per square inch. The maximum lift obtainable is nine feet from the ground to the shackle at its highest point.

(2) By using the sprags and sprag frame, the sheer legs can be used for any pull from horizontal to vertical. The limiting horizontal stress is 2 tons, after which the front of the lorry tends to lift as before, though pivoting now about the sprag frame. By weighting the front of the lorry this can be increased to 2½ tons.

(3) For horizontal pulling without using the sheer legs, three tons can be obtained comfortably. There is now no tendency to tip the lorry, but the sprag frame must be securely spiked to the ground or the whole thing will be pulled backwards.

The winding gear and sheer legs are in constant use for many purposes. They are very handy for shifting heavy girders or box sections so as to save manual labour, and demonstrations have been given to prove their value for this purpose. In photograph No. 1 the lorry is shown carrying a box girder section weighing 13½ cwt. The speed of the lorry in such cases is limited to about three or four miles an hour, and over rough country it is advisable to have a couple of men handy to steady the load from swinging too much and so damaging the sheer legs. Even with the limited scope imposed by peace conditions on R.E. work in manœuvres, some use was found for the sheer legs. For instance, gateposts have usually to be removed before tanks can enter a bivouac area, and whereas this is a tedious process by digging, they come out like corks under the sheers. Then again, the shore transoms on a heavy bridge have to be securely picketed down, and when the bridge is picked up these pickets have to be pulled up as well. This can be done in a few seconds by using the sheers. They are equally effective for removing picket holdfasts, etc. A further use is shown in photograph No. 2, where the lorry is launching a 30-foot tank bridge by means of the sheer legs. Attempts to erect an actual road block on manœuvres to be removed by the winding gear did not materialize, but this will

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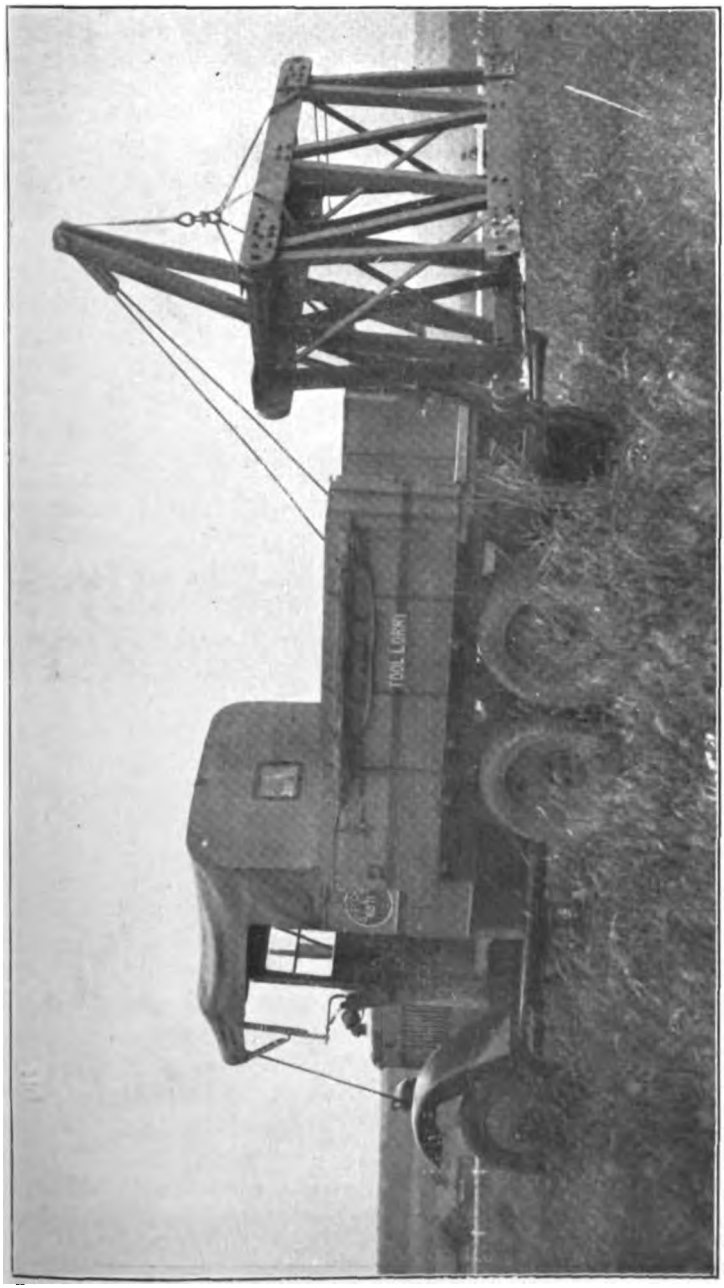
THE USE OF POWER TOOLS IN A FIELD COMPANY, R.E.



No. 1. Carrying a heavy box girder section (13 cwt.).

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No. 2. Launching a 30-ft. tank bridge in a few minutes.

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be tried shortly. Generally speaking, the winding gear and sheer legs have proved their worth. They only add a small weight to the lorry, and the sheer legs have never been found to get in the way. In any case, it only takes a moment to lower them to pass under a low doorway or for any other purpose.

The maximum pull obtainable with this equipment—three tons—is insufficient for many purposes, and a scheme is being tried to produce a more powerful type altogether. Briefly, the intention is to mount a similar type of sheers 20 feet high on a Guy medium 6-wheeler chassis. The sheer legs will be made to fold forward so as to enable the lorry to pass under bridges, etc., and will be erected when required. A five-ton pull will then be available, and the lorry will be able to launch the heaviest types of box girders, etc., now in use, thus eliminating all necessity for holdfasts, standing derrick, etc., which at present take up so much of the time.

In addition to these trials, we have experimented with a circular saw, driven off the lorry engine of a medium 6-wheel lorry. The saw is mounted across the lorry, and it takes up very little space. To drive the saw, the Carden shaft is removed and a chain pinion fixed behind the gear box, and the drive taken by chain to the saw spindle. This operation takes about ten minutes, and the saw is then ready to rip up anything up to 12″ x 12″ timber.

As regards the transport for these power tools and devices in the field, it seems fairly clear that each section should have its light lorry with winding gear and sheer legs; the heavier sheer legs on a medium lorry—if it proves successful—and the saw would both be very useful in a Field Company, but may find their way back to the Field Park Company. The compressor plant would also be very useful in each section, but will no doubt have to make a start at Company Headquarters only, and the same probably applies to other devices, such as power pumps and acetylene cutting plant. These and many other points connected with this subject will, no doubt, be settled in due course as we collect more knowledge and experience in this direction.

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A FIELD COMPANY IN MALABAR.

By "ASSAYE LINES."

IN August, 1921, the seditious teaching and the anti-British agitation, which were so marked a feature of Indian politics at the end of the War, culminated in a rising of considerable magnitude in Southern India among the fanatical Mahommedan inhabitants of the Malabar Coast. The Moplahs have always been known to be an extremely inflammable race, liable at any time to sudden outbursts of violence against the unbeliever, either Hindu or Christian, but in the past these outbursts had only had an individual significance and had seldom shown any signs of organization or been marked by any political features. The latest outbreak was, however, of quite a different character, and was the result of political and religious propaganda acting upon the minds of an uneducated and fanatical people; it took the form of an organized rebellion against British rule, and foresaw the formation of an independent Khilafat kingdom, which was to be the forerunner either of Indian Swaraj or of a new Mahommedan Empire, depending upon the individual religion and ambition of those who had schemed to bring it about.

When matters finally came to a head, the district (comprising an area of about 1,500 square miles, lying between the Nilgiris and the sea) was rapidly overrun by the rebels, and the responsibility for protecting the large European population of Calicut, as well as the large number of planters and police posts scattered throughout the area, was thrown upon the shoulders of the small British garrison at Calicut, which consisted only of a company and a half of infantry. The country is an extremely difficult one owing to the prevalence of close jungle and impassable rice-fields, and to add to the difficulties, the rebels at once cut the railway line linking the Malabar coast with the rest of India; they also blocked the roads, which are generally good, by felling trees across them and destroying numerous bridges, while the situation was further complicated by the fact that a small detachment of the garrison was cut off in Malapuram, an important village near the centre of the disturbance, where it had been necessary to send them shortly before the commencement of the outbreak.

On receipt of the news of the rising, two movable columns were mobilized at Bangalore, and were dispatched by train to the disturbed area, the whole force amounting to about 1 battalion of infantry, 1

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troop of cavalry, 2 sections R.F.A. 2 platoons* of Sappers and Miners, and 1 company of pioneers. The railway to Calicut was quickly repaired, with the aid of the Sappers and Miners, Malapuram was relieved by the columns working north from the railway near Shoranur, and with the passing of the immediate crisis there began the first phase of the operations designed to overcome the power of the rebels and re-establish law and order throughout the area. The conduct of these operations was largely determined by a difficulty inherent in all warfare against a savage enemy, that of the lack of an objective, as the rebel bands, well served in the way of intelligence, were able to concentrate or disperse at will, and could find a safe refuge in the depths of the forests or in the hilly jungles where the troops could not follow. The procedure adopted was that of sending small columns to traverse the affected area, with the double purpose of "showing the flag" and of forcing an action in the event of any considerable body of the rebels being met; and, as these columns had of necessity to be self-supporting for considerable periods, a great deal of "first-line" sapper work was entailed in order to allow cart transport to accompany them. The Malabar coast is a country of heavy seasonal rains, and the Moplahs from the first had shown considerable zeal in destroying the numerous road bridges; over the greater part of the area the roads were closely lined with thick jungle, which offered extremely favourable opportunities for ambush, and made it easy for the rebels to impede movement by felling trees or large clumps of bamboo across the roads; as a result it was essential to have a proportion of sappers with each column which was sent out, not to maintain communication between the column and its base, which would have required more men than were available, but to allow the column to move at all and to return when its task was completed.

As there was practically no local supply of material suitable for bridging purposes, most of the work done was of a very temporary character, except in those cases where the damage was less serious and could be repaired. A certain bridge was built by friendly Moplahs during this period, and was strengthened by a platoon of Sappers and Miners to enable it to take a 30-cwt. lorry. The brick arch which had been destroyed by the rebels had a clear span of 27 feet, and the local design consisted of two outer trestles, each of which was made up of three small tree trunks, cut with a fork at the top to carry the transom, and without any attempt at ledgers, trestle diagonals, or struts. The road-bearers were nine-inch spars cut near the site, and the roadway consisted of split bamboo and areca nut trees tied down with thin coir rope; although the effect was reminiscent of Heath Robinson, the bridge was still standing after a column, accompanied by cart transport, had passed over it. The sappers, working against

* Now "sections."

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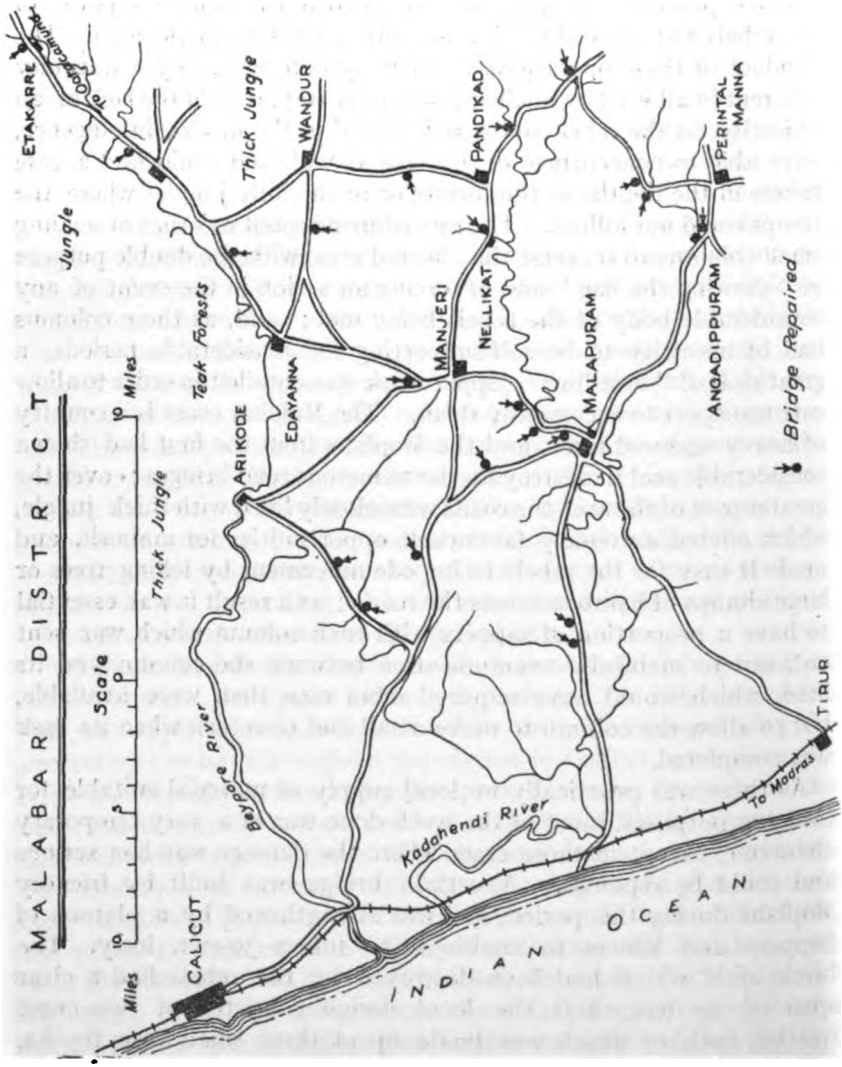
time, strengthened the bridge as originally constructed by the addition of the central trestle and of diagonals and struts, while the roadway was improved by adding another layer of decking, consisting of 1½-inch planking obtained from the doors and partitions of neigh-



bouring houses. Another piece of temporary bridging, which was carried out by a platoon accompanying a column and carrying practically only its first-line equipment, was the construction of a 70-foot timber trestle bridge to take 30 cwt. lorries. In this case, a certain amount of squared timber was available in the vicinity in the shape of

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door frames, wall plates, floor joists, etc., although it had to be collected by bullock *bandy* from scattered villages anything up to five miles distant, and in spite of the fact that the road had to be diverted, the bridge was completed and opened to traffic after two days' work. Unfortunately, this bridge was raided and destroyed by the rebels before a photograph was taken of it, but it formed a very good example of emergency work carried out under great difficulties in the way of time and material. The work of the sappers during this period was not confined to bridging, but included the clearing of roads, the crossing of a broad fast-running river by night by means of a flying ferry, the construction of a corduroy road for 18-pdrs. up the steep, jungle-covered slopes of a hill, as well as a certain amount of work in connection with camp defences. The best example of a road block consisted of two large bamboo clumps each about fifteen feet thick, and of ten teak logs of an average size of two feet by two feet by 35 feet; the bamboo clumps could not be dragged aside owing to the thickness of the jungle, and the logs, which had been hauled into position by captured Government elephants, were much too heavy to move quickly. Fortunately the column was accompanied by fifty coolies who had been provided with billhooks, and, with their assistance, one platoon of sappers and one platoon of pioneers cleared the road in fifty minutes by cutting through the bamboo and by sawing and dragging aside the teak logs.

After a short time, the employment of small mobile columns working from a common centre was found to produce little result, and, as more troops became available, the operations entered upon a second phase, in which a system of garrisoning was adopted, small bodies of troops being posted in all the more important villages, and each garrison being made responsible for a definite area in which it worked. The rationing of these outlying posts was carried out by means of motor and cart convoys, which made imperative good road communications throughout the district, and, finally, the arrival of large reinforcements, including a battery of armoured cars reputed to have a live back-axle load of six tons, made the semi-permanent repair of all road bridges essential. The two Sapper and Miner platoons which had accompanied the original movable columns, and which had only carried their first-line equipment, were replaced by a complete Field Company, and steps were taken to organize the work and provide for the supply of all bridging materials required. The officer of the P.W.D. in whose district the rising had taken place was appointed Executive Engineer to the force, and was made responsible for the supply of material and also for the ultimate design of the bridges to be repaired, as it was decided to bear in mind as far as possible future civil requirements, although the actual construction and the question of priority of work remained of necessity in the hands of the military commander. Squared timber of various sizes was

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obtained in large quantities from Calicut, which is the port of outlet for an important timber producing area ; stores such as spikes, dogs, telegraph wire, nails, etc., were collected, and extra engineering tools which were likely to be useful were borrowed from the P.W.D. These tools included extra blocks and tackles, rope, carpenters' tools and, most useful of all, two six-ton jacks. The timber and other stores were conveyed from railhead at Tirur to a central dump at Malapuram, and arrangements were made for the engineer reconnaissance to be carried out of those bridges whose details were not already known.

During a period of about three months, twenty-five bridges of spans from twelve feet upwards were either repaired or strengthened to take the armoured car load, the work carried out varying from the construction of a 70-foot timber trestle bridge (in place of the temporary bridge referred to previously) to the replacing of steel roadbearers on the original seating and the provision of new decking. In addition to this bridging work, a certain amount of work was done in the way of road maintenance and improving camping facilities, while all important isolated bridges were protected by a small blockhouse surrounded by barbed wire, and designed for an infantry garrison of about ten men. The most important type of this miscellaneous work was, however, that carried out in connection with camp defences. The fanatical nature of the rebels and their extremely good intelligence service and knowledge of local geography made it essential that all camps should be of the close perimeter type, and that they should be protected by as stout an obstacle as possible. The importance of this was recognized early, but it was brought home in earnest when a small post in Pandikad was attacked by the Moplahs, who succeeded in getting inside the defences and caused severe casualties before they could be accounted for. The post was rushed at dawn by a band of about 2,000 rebels, and the laterite brick wall which took the place of an obstacle was overturned by the sheer weight of the rush ; the impetus carried the leaders of the attack inside the perimeter, and it was only the enfilade fire of two machine-guns, sited to fire along the line of the obstacle, which saved the situation. The type of obstacle which was most commonly employed is referred to in the following notes, which it is hoped may be of interest.

I. BRIDGING.

(*a*) *Materials.*—The most useful size of timber supplied was 12′ x 9″ x 3″, and was used for decking, cribwork, trestles, and on one occasion for roadbearers, its value being greatly increased by the fact that it could be carried in case of necessity in army transport carts or in Ford vans. 10″ x 6″ and 10″ x 5″ of various lengths were the stock sizes used as roadbearers, and a certain amount of 12″ x 6″ was reserved for the transoms of two-legged trestles.

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600-lb. telegraph wire was used for Spanish windlasses, holdfasts, etc., and 6″ and 9″ spikes were supplied for fastening down the roadway and for the construction of the smaller trestles. 12″, 15″ and 18″ bolts were either supplied or made up for use on the larger trestles and for bolting on all transoms and ledgers.

Suitable material was extremely scarce locally, but was used whenever it was available, chiefly for handrails, longitudinal bracing and for cribwork.

(*b*) *Abutments.*—As a large number of bridges in the area consisted of rolled steel joists carrying either a timber or a metalled roadway, the abutments were the usual places to be attacked, the normal procedure of the rebels being to work at the laterite brickwork with picks and crowbars until the roadbearers dropped into the river. In repairing the abutments, the loose and damaged brickwork was removed until a level seating was obtained, and the abutment was then built up with timber cribwork until the original level was reached. In one case where the abutment had been entirely demolished, it was necessary to erect a shore trestle close up against the unsupported wall of earth.

(*c*) *Trestles.*—A large amount of trestle work was done, as, in addition to repair work, several bridges had to be strengthened to take the armoured car load. Trestles up to 24 feet in height were made up of 9″ x 3″ scantlings, the smaller sizes having two legs of three 9″ x 3″ timbers each, and a 12″ x 6″ transom, the larger sizes having three legs and a 10″ x 6″ transom. The three scantlings making up each leg were bolted together with a three-inch gap between each, which increased the strength of the leg and simplified the bolting or spiking in of transom, ledger and diagonals. Several trestles were made up of local timber, 12″ x 6″ and 10″ x 6″, and in these cases both ledger and transom were let into the legs and bolted through.

(*d*) *Roadbearers.*—Timber roadbearers were used for spans up to fifteen feet, mostly of 10″ x 6″ and 10″ x 5″, although over a ten-foot span 12′ x 9″ x 3″ roadbearers were used on one occasion. R.S.J.s of various sizes and 70 lb. steel rails had been used in the original construction of most of the bridges, and wherever possible these were salved and replaced, although the very small section modulus of the steel rails made them unsuitable for use in spans of any length. Distance pieces were always put in at the abutments and in the centre of the span, and the roadbearers were wired together by Spanish windlasses of telegraph wire.

(*e*) *Roadway.*—12′ x 9″ x 3″ and 8′ x 9″ x 3″ planks were used for the roadway, each plank being spiked down to the roadbearers or to the plank below it. Double decking had to be provided in all cases for use of armoured cars, the bottom layer, which carried the handrails, being laid transverse, and the top layer parallel to the roadbearers.

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(*f*) *Bridge No.* 1.—This bridge, which had already been twice repaired for light traffic, consisted of two spans of 27 feet, with a central trestle made up of 70-lb. rails standing in a concrete bed. The roadway had been destroyed, and the roadbearers, three 10″ x 5″ R.S.J.s in each span, had been thrown into the river, but the central trestle was left standing. At the time when the bridge was repaired, the water level was 19 feet below the bottom of the roadbearers, and as the bridge was situated on a sharp curve of the river, the centre of one span had five feet of water below it, while the other span was dry. It was decided to repair the bridge as quickly as possible to take lorry traffic, and to strengthen it later by adding timber trestles in the centre of each of the original spans.

The replacing of the roadbearers and roadway presented no difficulties, and the smaller trestle, which was made up on a sandbank just below the bridge, was brought into position and raised by block and tackle slung from the roadway. Owing to the slope of the abutment walls, however, the span at water level was less than the height of the second trestle (24 feet), and this trestle had to be towed below the bridge with the transom up-stream and raised from that position, instead of the normal method with the legs parallel to the roadbearers. The trestle was made up of 16′ x 9″ x 3″ scantlings, and had three legs at four feet centres, each leg consisting of three pieces of 9″ x 3″ with strapped joints; trestle diagonals were provided in the same way. The transom was 12′ x 10″ x 6″, and the ledger was made up of 9″ x 3″ timber. Owing to the weight of the timber, the total weight of the trestle was approximately 1½ tons.

Four tackles were used; two main tackles slung from the roadway near the abutment were made off to the tops of the outside legs near the transom, two preventer tackles slung from the bridge near the original central pier were made off to the feet of the legs near the ledger. The transom was raised by means of the main tackles; by taking up more rapidly on the longer of the two, the trestle was gradually turned over, and the feet of the trestle were brought into position by means of the preventer tackles, aided by crowbars and levers used under water. When the feet of the trestle were resting approximately in position and the transom was lying against the abutment wall, the preventer tackle was cast off the feet and was lashed to the tops of the legs, and the trestle was then pulled vertical.

Two platoons were employed on this work, which included improving the approaches, making a turning point for armoured cars, and building a small blockhouse, and the bridge was ready for lorry traffic after two days' work, and was opened to armoured cars two days later.

(*g*) *Bridge No.* 2.—This bridge consisted of two 34-feet spans, 20 feet above ground level, with a stone pier in the centre of the gap. The roadbearers in each span were four 16″ x 6″ R.S.J.s

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carrying single 3" decking. One span had not been touched, but in the other the decking had been destroyed, two of the roadbearers had been thrown into the water, and the shore abutment, which was built of laterite blocks in cement, had been attacked and badly damaged. The two roadbearers which had fallen were bent through an angle of about twenty degrees, while the other two were still resting precariously on the damaged abutment.

A derrick was erected through the centre of the roadway, and the two R.S.J.s, which were still in position were lowered on to a ledge in the abutment wall, so as to enable the abutment to be repaired. This was done by digging down to a level seating and building up to the original level with timber cribwork carrying a shore transom of 12' x 10" x 6". The two undamaged roadbearers were placed in position as the outside roadbearers, and the two which had been bent were raised and placed between the two outside ones at about three feet centres.

Owing to the amount of bend in the R.S.J.s, they would not sit upright, and were therefore supported by block and tackle from the derrick which had been used to raise them. Distance pieces having been put in between the ends of the girders, their centres were pulled together by means of block and tackle until the two were practically straight. Three Spanish windlasses of 600-lb. telegraph wire were then twisted up until they took the strain, and the blocks and tackles were cast off. Double decking of 9" x 3" timber was added, and the bridge was opened for armoured car traffic 2½ days after work was first started on it.

(*h*) *Bridge No.* 3 (see Photographs 1 and 2).—Consisted of two iron lattice girders over a gap of 100 feet, carrying a metalled roadway, which was supported on built-up iron cross-beams at five-feet intervals. The ironwork of the bridge weighed from 45 to 50 tons, and the road metal approximately the same, the bridge being supported on brick abutments at a height of about 20 feet above ground level. The rebels had attempted to destroy the bridge by attacking one of the abutments with pick and crowbar, and had persisted in their attempt until the end attacked had commenced to settle; probably the first movement of the bridge had caused them to think that their work was accomplished, besides bringing home to the men working underneath the fact that their position would not be exactly enviable when the bridge finally collapsed. When the bridge was examined, it was found that the two bedstones at the damaged abutment—these stones were approximately 6' x 5' x 3', and were bolted to the girders—had been undercut to such an extent that they were resting on a bearing of about 2' x 9", consisting of crushed and broken brickwork, and that one girder had sunk about 9" and the other about 3". It was decided that the bridge should be left until more suitable appliances in the way of heavier lifting jacks,

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bricks, cement, etc., could be obtained, but next morning it was found that the lower girder was still settling, and that it was now 18" below its original level. In addition, news had been received which pointed to the possibility of the road being required for operations, and steps were at once taken to reduce the weight on the seating by removing all the road metal on the bridge. Two six-ton jacks—the only lifting appliances available—were then put in position below the bedstone, and the weight of the girder was taken on them, the broken brickwork being cleared out from behind the jacks once the weight had been taken. The inner half of the abutment was then packed up with timber below the girder, which was slowly raised by means of the two jacks working together, the timber work being built up as the bedstone lifted. When the girder was back at its original level, the jacks were removed and a second closely packed timber pier was built in their place and wedged tightly against the bottom of the bedstone. A similar procedure was then adopted in the case of the other girder, and, after a proportion of the metalling had been replaced, the bridge was opened for traffic.

In order to facilitate the eventual permanent repair of the bridge, and also as a measure of precaution, a timber trestle was erected close to the damaged abutment and wedged tightly against the girders. This trestle was made of very heavy teak logs found on the site, and consisted of two legs, 20' x 18" x 18" immediately under the girders, with a 12" x 12" ledger and transom let into the legs, and with diagonals and struts of about 9" diameter logs. The bridge was opened for traffic after two days' work, and a further two days were spent in building and erecting the teak log trestle.

II. CAMP DEFENCES.

An early type of perimeter was formed of A.T. carts and bamboo, the carts being fastened together and the long bamboo trees with their spiky branches being tied to the carts (see *F.S.R.*, Part II, para. 179). This form of perimeter was often used when on the march, and when carts were not available, the bamboos were anchored down to stout posts driven into the ground.

There was another type of obstacle, originally designed by an infantry officer, which was employed on several occasions in the protection of camps which were more or less permanent. Bamboo tripods about six feet high were erected at intervals of about 20 feet, wire or thin strips of bamboo being used to bind them together, and the feet of the tripods were let into the ground or anchored down. Horizontal bamboos with the thorns left on were then tied to the legs of the tripods, three lines of horizontal bamboo in front and three behind. Pointed stakes were added pointing upwards and outwards, and were made fast to two of the horizontal lines of bamboo.

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A FIELD COMPANY IN MALABAR.

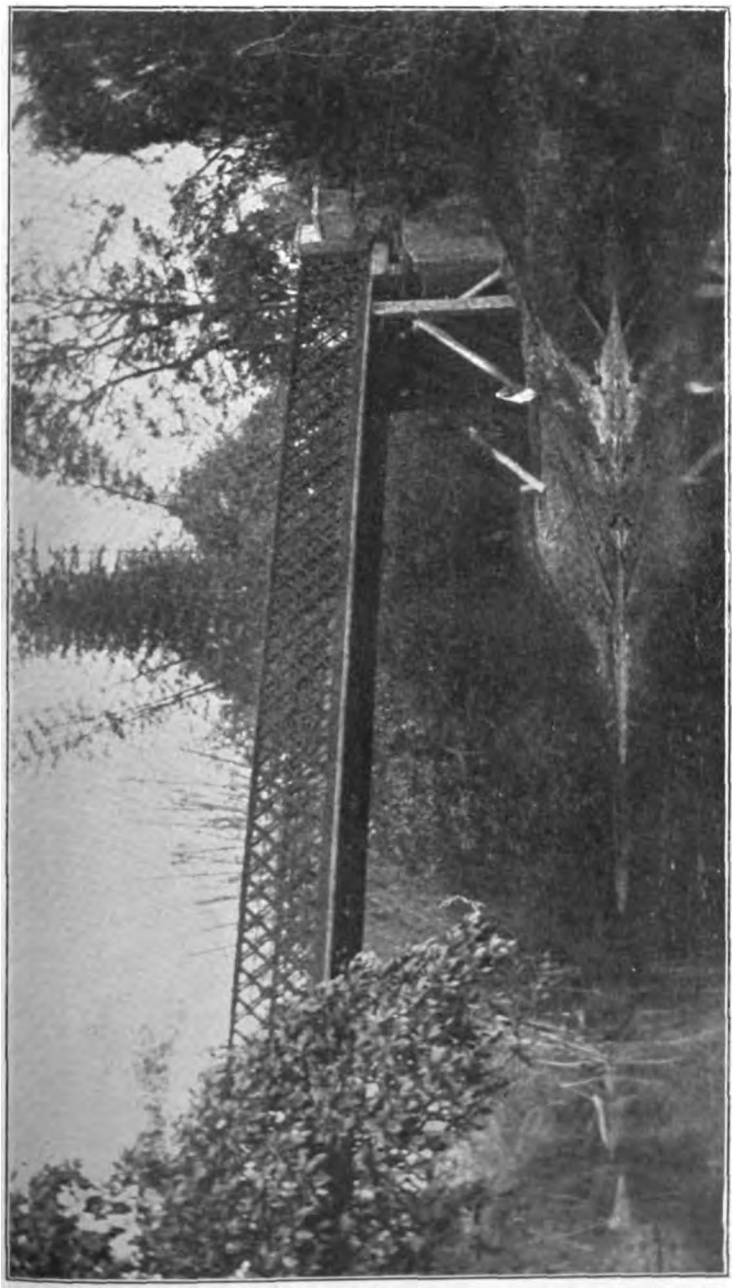

Photo No. 1.—Repair of Lattice Girder Bridge.

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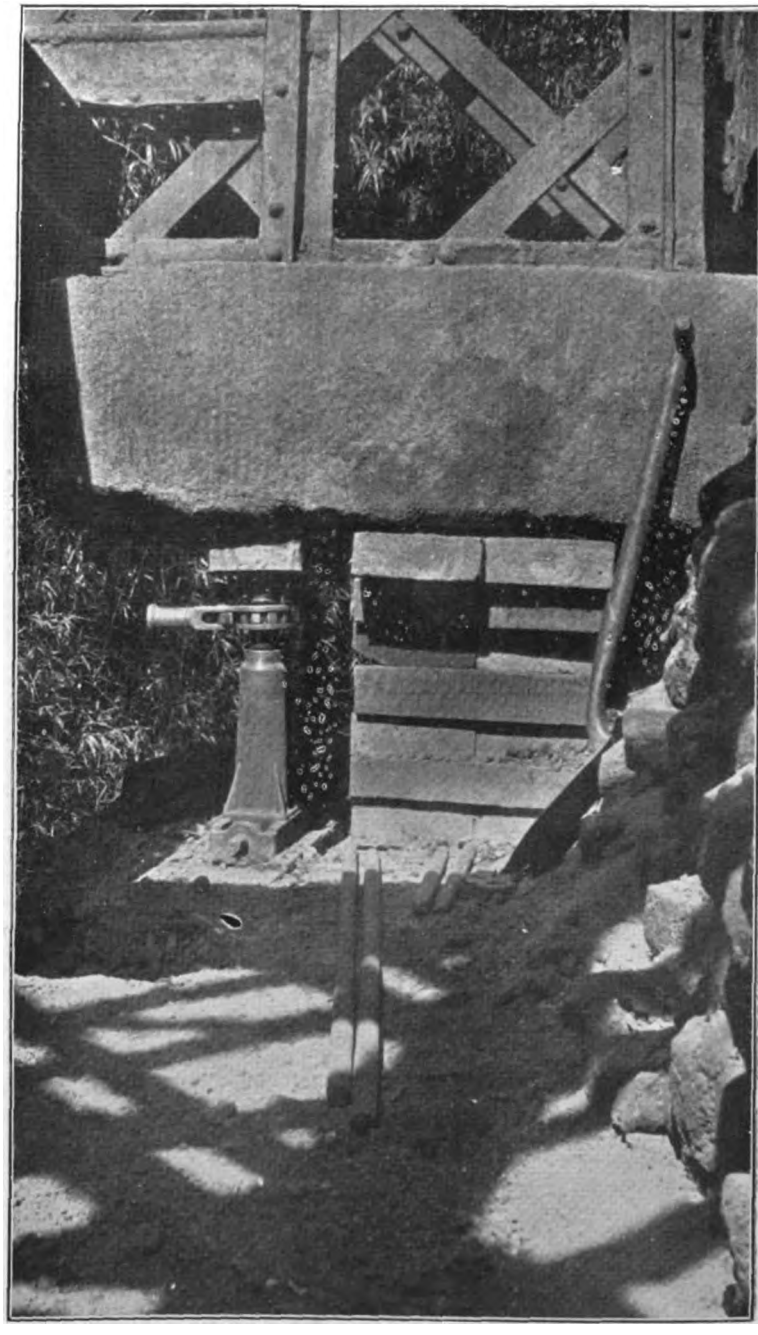

Photo No. 2.—Raising bedstone of Lattice Girder Bridge.

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Although only possible in a country where bamboo is plentiful, the resulting obstacle is extremely strong; with a little practice it can be erected very rapidly, the only materials required being bamboo and cutting tools, and if necessary the whole work could be carried out by coolie labour.

Owing to the fact that the strength of the garrisons in the more important posts was continually varying, permanent camps were usually constructed with a central keep capable of defence by one platoon, and round this keep ran an outer obstacle, within which there was sufficient room for the largest number of troops who would occupy the camp. This area was then divided into compartments by means of " switch " lines of obstacle, so that any intermediate formation could find accommodation suited to its numbers. The actual siting of the outer obstacle and of the keep depended naturally upon local conditions, but the principle remained the same.

III. Miscellaneous.

Among other tasks which had to be performed was the salvage of two motor lorries from a river into which they had been thrown by the rebels in the early days of the rising. One of the lorries was floated by means of two country boats, after the stones with which the boats were filled when the lorry was made fast had been thrown out. The bottom of the river was filled with boulders, and the lorries had to be floated some distance before a suitable place was found for cutting a ramp to lead them up to the road.

Other jobs varied between helping in the construction of a telephone line between Tirur and Malapuram and forming an escort to a number of Government elephants which had been recaptured from the rebels, and at all times the most urgent cry was for at least some sappers to accompany any column which was ordered out. On one occasion, an N.C.O. and eight men had been left behind in charge of a dump, and the N.C.O. was ordered by the Post Commander to detail a party of Sappers and Miners to accompany a column which was going out next morning. Having been taught to obey orders he did so, but as he had other work in hand he found he could only spare two men. Two sappers accordingly reported to the commander of the column next morning, and as they had been told to bring tools, one of them carried a felling axe and the other a handsaw. The magic of their presence was enough, and they accompanied the column without incident until it had completed its task. If it is true that in war the moral is to the physical as three to one, then the presence of the two sappers may be said to have been trebly justified

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THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

By CAPTAIN C. C. S. WHITE, M.B.E., R.E.

Two previous articles on this scheme have already been written and published in the *R.E. Journal*,* but as work is progressing so rapidly no apology is offered for a third.

If any R.E. officer should find himself with time at his disposal in Ireland, he would find a visit, or several visits, to the various sites extremely good value.

The constructional work at present in hand consists primarily of six tasks :—

(1) The excavation and erection of embankments along the Shannon between Banagher and Portumna, embanking and dredging Lough Derg to obtain a storage of 11,500 million cubic feet.

(2) Earthworks between Killaloe and O'Briensbridge and the provision of an adequate means of discharging the tributary rivers and rivulets.

(3) Erection of the weir at Parteen Villa and of the intake building to the head race.

(4) The construction of the head race canal, which is 7¾ miles long and has a cross-section of approximately 10,000 sq. feet, with embankments up to 60 ft. high, and the necessary syphons, culverts and road bridges.

(5) Construction of the dam, power-station and two navigation locks at Ardnacrusha.

(6) The excavation for the tail race.

These may be visited on any day of the week, work on them is being done practically continuously during daylight and in certain cases 24-hour shifts are being worked on special jobs. Permits must be obtained from the Resident Engineer, Shannon Power Development, Strand Barracks, Limerick, but there is no difficulty about this, as every endeavour is made to encourage visitors.

I. HEADWORKS.

(*a*) *Above the Weir.*

The earthworks above the weir have now reached 75% completion. The embankment on the north side of the river immediately

* *R.E. Journal* for June, 1927, and September, 1928.

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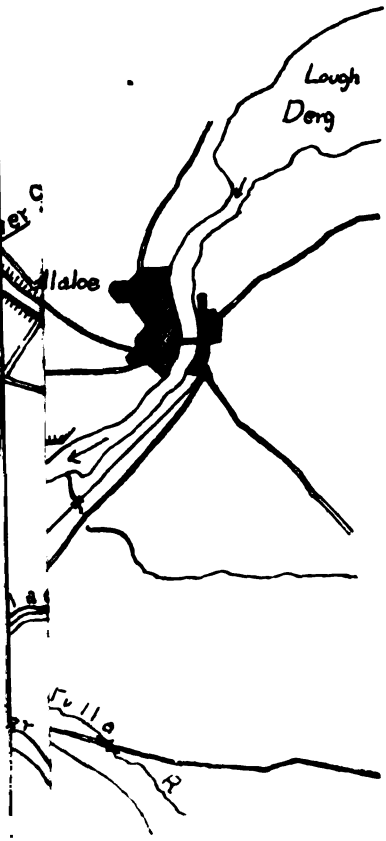
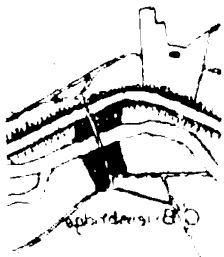
CH. Fig. 1. TO . MA_I.





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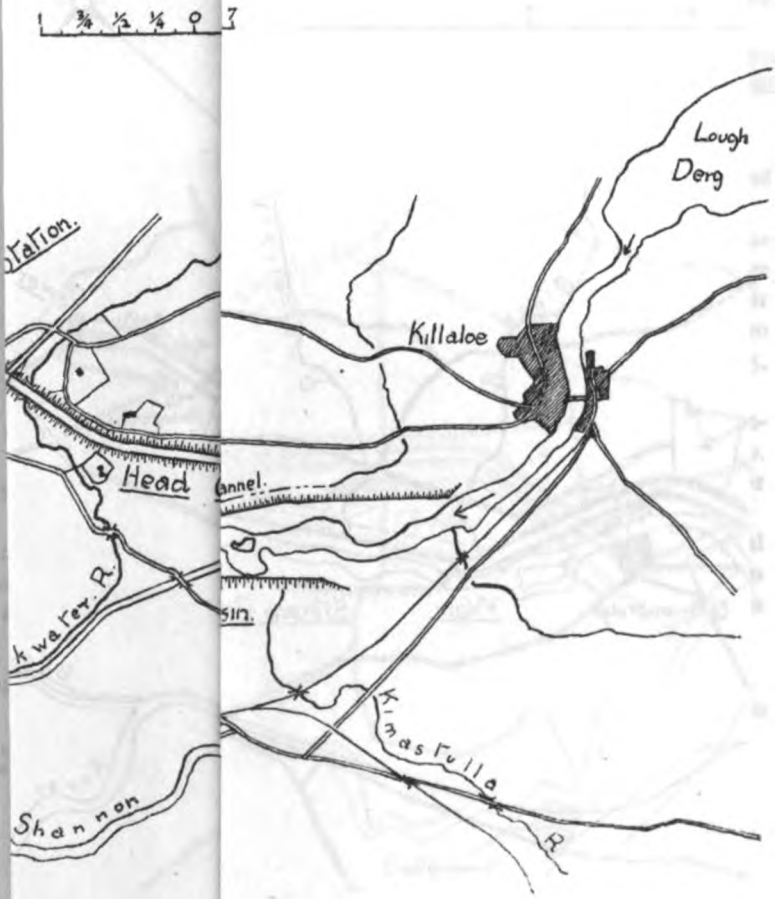
H SHOW SCHEME. Fig. 1.



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above the weir is now finished (see sketch showing general plan of Shannon scheme in *R.E. Journal*, June, 1927, reproduced herewith) (Fig. 1). Work is now being done on the embankment on the south side.

The Kimastulla river is being taken through a diversion channel behind this embankment, and its point of discharge will eventually be below the weir.

The Ardeloony river is not interfered with by the works, as its level is such that it can discharge into the storage basin which will be formed between the embankments.

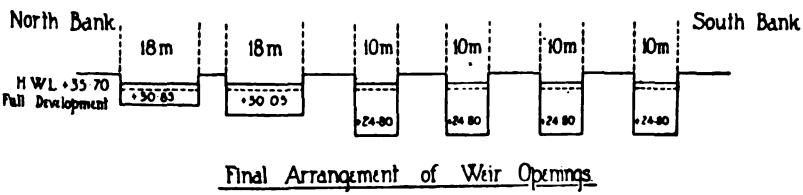
(*b*) *The Weir.*

The original design of the weir was determined by the results of model experiments carried out by the German engineers in Berlin.

The maximum flood to be discharged through the weir is taken as 32,400 cusecs, or 920 cubic metres per second, assuming no discharge through the head race canal. To provide for this, the following weir openings were taken: four openings, each 18·0 metres wide, two with weir crests at level +30·85 and two with crests at +30·05, and two deep sluices each 10 metres wide with crests at +24·80.

The upstream water level is fixed at +35·70 for the final development, and the downstream high-water level is estimated at +28·20. The average level of the river-bed at the weir is +24·50, the upper surface of rock being +22·00.

In order to provide better regulation at low-water level, the original design of the weir has been modified, and it will now consist of two openings, each 18·0 metres wide and four deep openings 10 metres wide, with weir crests at 24·80 thus:—



Final Arrangement of Weir Openings

FIG. 2.

This design enables the weir with one of its deep sluices closed for repairs to discharge the maximum flood of the Shannon, 920 cubic metres per second, with the head race closed.

The 18-metre sluices will be closed by single steel roller gates 2·7 [illegible] 3·5 metres deep respectively, and the deep sluices will have double roller gates divided horizontally and of a total depth of 10·9 metres. The hoisting machinery, which can be worked electrically or by hand, will be housed in a roofed gangway immediately above the gates. As a safety measure and for cutting off the water during

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repairs to the sluices, recesses for stop beams are provided in the piers; the steel stop beams being lowered by a crane of special design.

The weir building site has two overhead travelling cable cranes

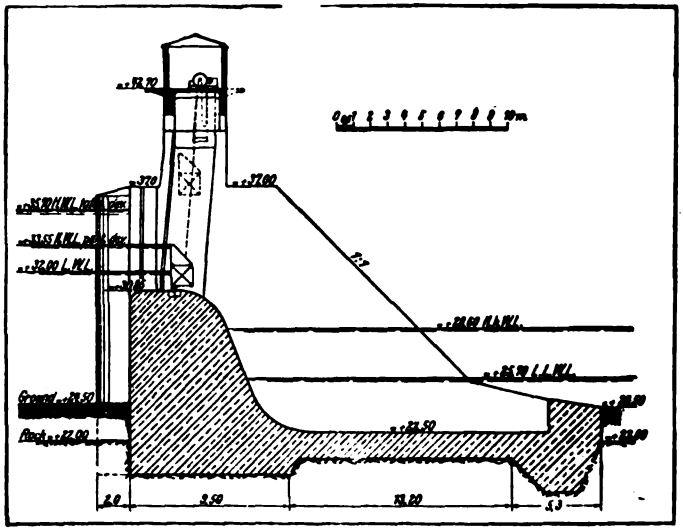

FIG. 3.—Cross Section of Weir.

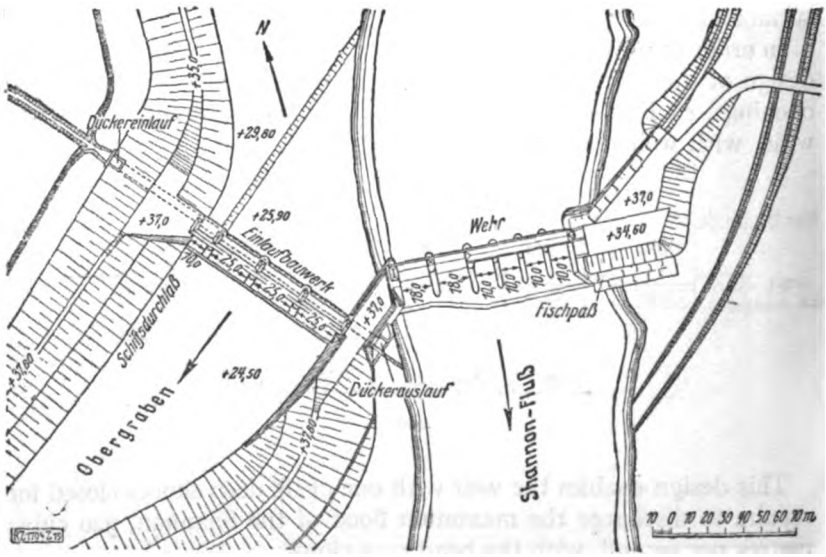

FIG. 4.—General Plan of Weir.

with a radius of about 450 metres, which extend over the Shannon and over the greater part of the intake building site on the right bank. Each carrier is built to lift five tons. On the right bank, the cranes have a common fixed tower, on which the control huts are

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:rete to Carrier

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of Cable Crane.

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mounted. On the left bank there are two separate towers, both movable, so that the cranes can work over the whole area of the weir building site.

The construction of the second coffer dam was identical with that of the first (already described in previous articles), with the one exception that concrete was substituted throughout for the puddled clay, and so the thickness of the walls was reduced to three feet.

Excavation has to be carried down below the bed of the river to a depth of 3·5 metres, first through a top layer of earth and boulders, then through fissured sandstone rock into sound, hard, red sandstone rock, on which the superstructure is founded. The rock drilling is done with compressed air-drills operated by electrically-driven Flothman compressors. The excavation grows more difficult as the depth increases, owing to percolation through fissures in the rock below the coffer dam. During periods of high-water in the Shannon, this percolation is so great that it requires five pumps having a combined output of 2,000 cubic metres of water per hour, in order to keep the interior of the coffer dam sufficiently dry to allow excavation to proceed. Excavation is carried on continuously day and night, except for a blasting interval every five hours.

The rock is made watertight by cement grouting. Two rows of holes are bored to a depth of five metres below the weir sill, thus cutting well through the fissures in the rock. After the weir sills have been concreted, the bore-holes and consequently the cracks and fissures are filled with cement grout under a pressure of six atmospheres. In this way, a watertight barrier is formed along the upstream side of the weir to a depth of 8·5 metres below the original rock surface. This, it is hoped, will prove sufficient to prevent water percolating under the weir when the water level is raised to full development.

The actual concreting of the weir is done as follows :—The aggregates from the silos, namely, sand, chips, and broken stone, are dropped into tipping wagons in a tunnel under the silos. . The wagons are provided with the necessary quantity of cement by means of an automatic weighing machine, and then raised up a ramp to the concrete mixer. The plant for the weir and intake building is in one hut, and consists of two 1,000-litre mixing machines. The finished concrete is first put on a conveyor belt 20 metres long on an arm that can move round a semicircle. By means of this belt, part of the intake building can be concreted directly. For the concreting of the rest of this building and the weir, the belt conveys the concrete to the carriers of the overhead cable crane, which in their turn bring it to the required place (see Fig. 6).

The spillway basins below the weir are faced with granite blocks 40–60 cubic measurement, quarried at Aughhim, Co. Wicklow. As soon as a layer of foundation concrete for the spillway is ready,

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the granite blocks are laid by a special gang of masons and jointed with cement mortar. The stones forming the stop wall of the spill basin are anchored to the concrete by means of round steel bars (see Fig. 7).

To avoid upward pressure on the concrete bed of the spill basin due to water percolating through small cracks and fissures, earthenware pipes are laid along the natural rock fissures, cased with lean concrete, and provided here and there with vertical outlet pipes extending through the concrete to the surface of the spill basins.

Note.—Reduced levels and all dimensions for the weir have been given in metric units to conform with the diagrams kindly supplied by the contractors, Messrs. Siemens, Baunion.

Fish Pass.—A most spacious fish pass will be constructed around the eastern extremity of the weir. The silver fish will leap up the 30-ft. rise by twenty steps, each step only 18 inches high, and connected by pools 23 feet long and 13 feet wide; every third pool will be 40 feet long—a rest pool.

II. HEAD CANAL.

Very marked progress has been made in the construction of the head canal. It has now reached 75% completion. And it is anticipated that it will be ready for water provisionally in March, 1929, but this actual date is naturally largely dependent upon weather conditions.

A full description of the plant used for building the banks and a cross-section of the canal have already been published.

III. POWER-STATION.

The power-station is, perhaps, the most interesting of all the works at the present moment.

(*a*) *Foundations.*—All excavation is now completed. The foundations are built on blue limestone rock, which was found to be homogeneous with the exception of one small part, immediately under the proposed location of the draught tubes of Nos. 1 and 2 turbines, where an earth pocket was discovered. In order to avoid any risk of the concrete cracking, the earth was removed for a further depth of 10 feet and replaced by a reinforced concrete raft some 4,300 sq. ft. in area. The ruling pressure on foundations has been taken as four tons per sq. ft. throughout.

(*b*) *The Dam.*—The concrete work of the dam is practically completed. It has reached the floor level of the sluice-operating gear house. On the head race side of the dam there are six inlets. Only three of these will be used for the partial development, the other

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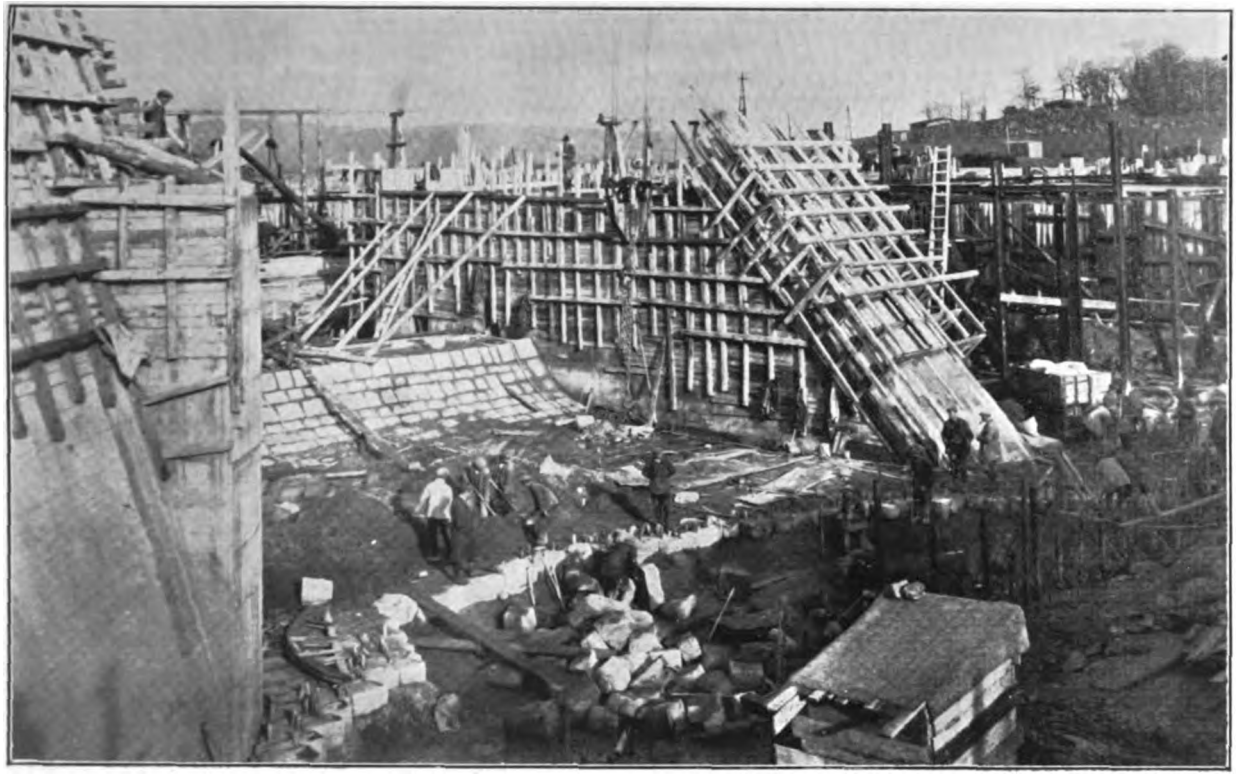

Fig. 7.—Granite Facing of Spill Basin.

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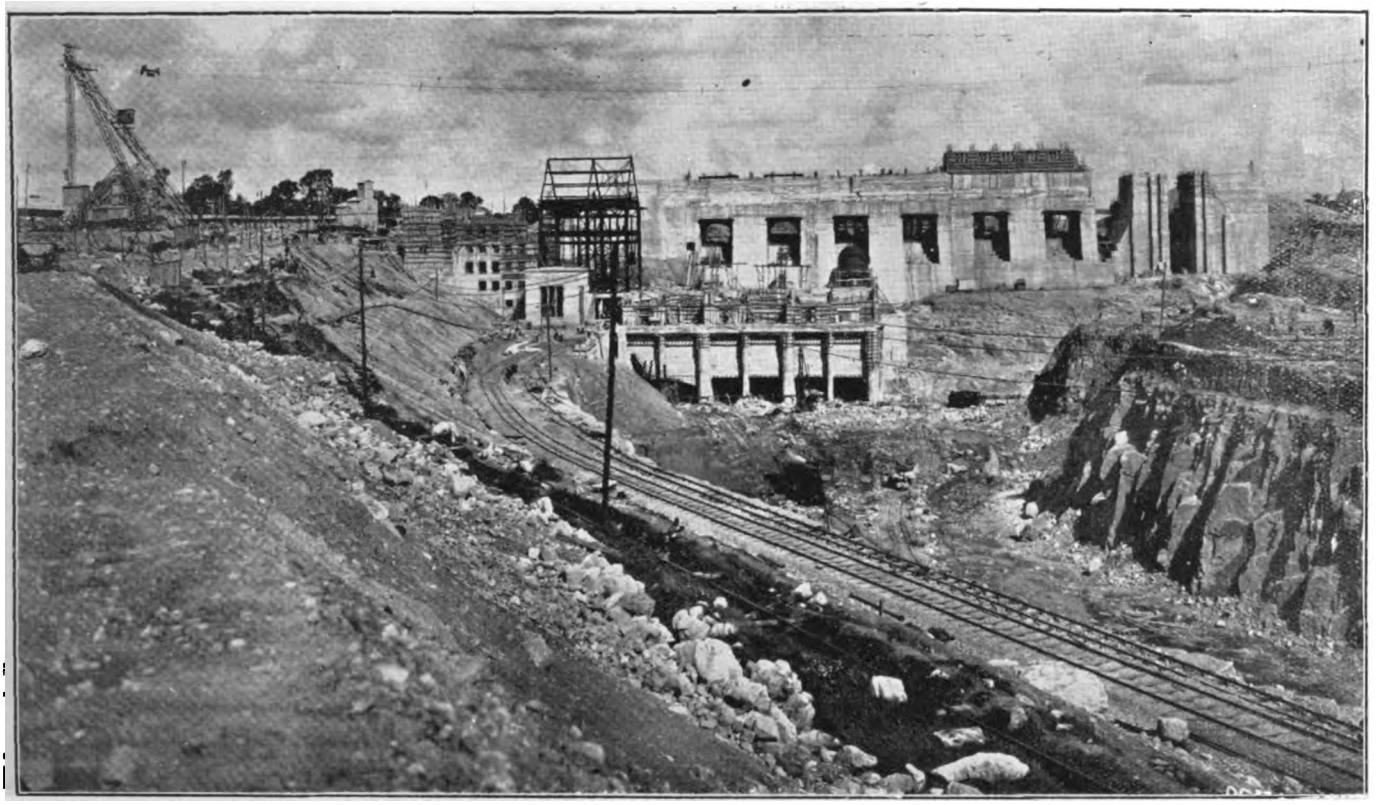

Fig. 8—General view of Dam, etc. The openings for the Waste Water Channel and Navigation Locks can be seen on the right.

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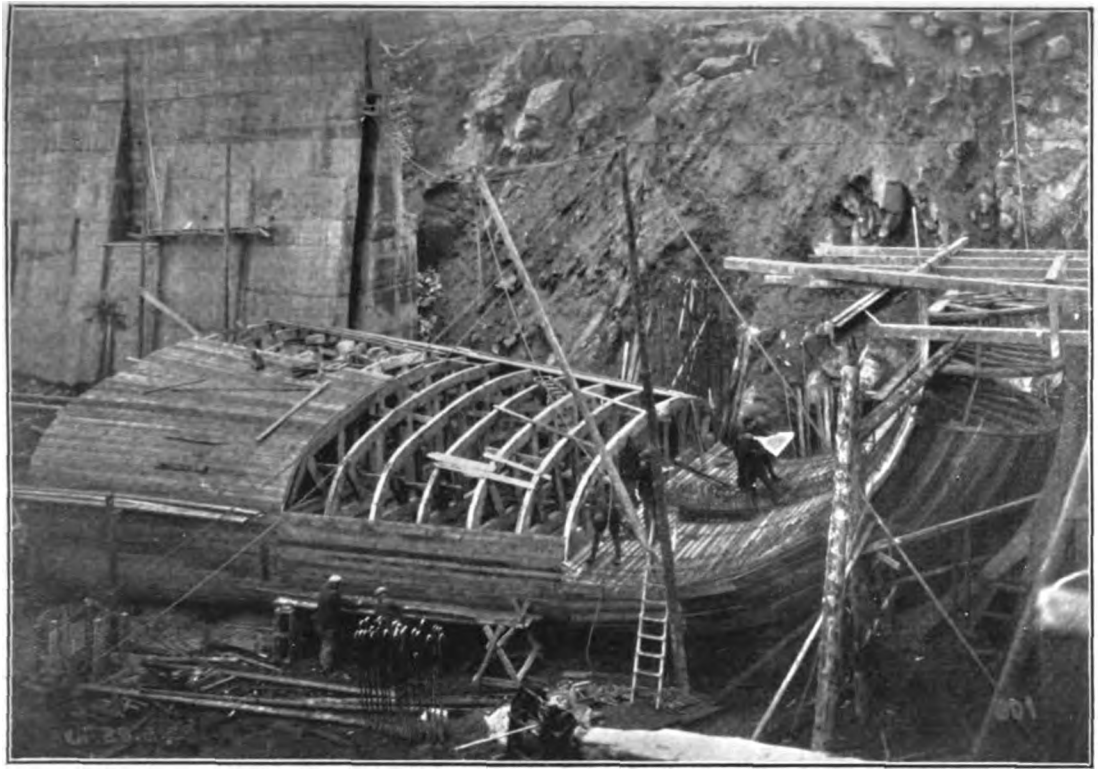

Fig. 11.—False Work for Draught Tube.

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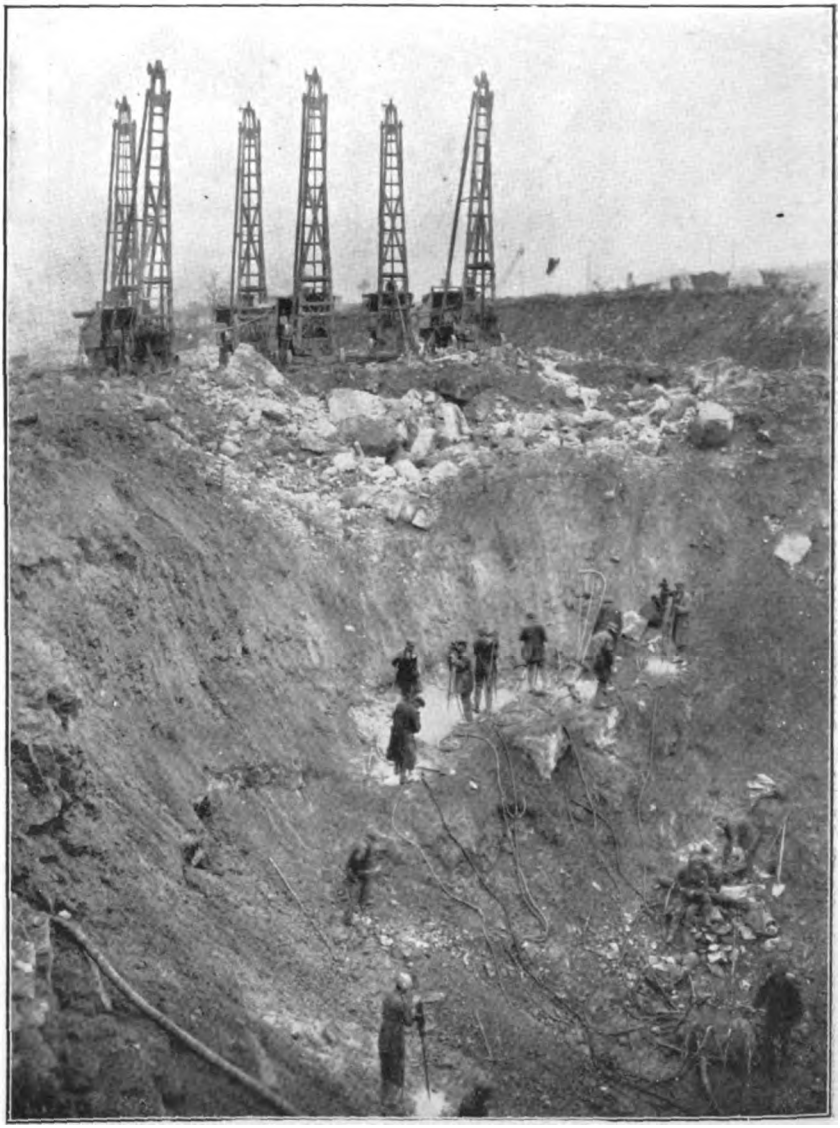

Fig. 13.—Belgian Boring Machines.

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three are being closed by temporary walls of reinforced concrete. It will be interesting to see how these will be removed when the time

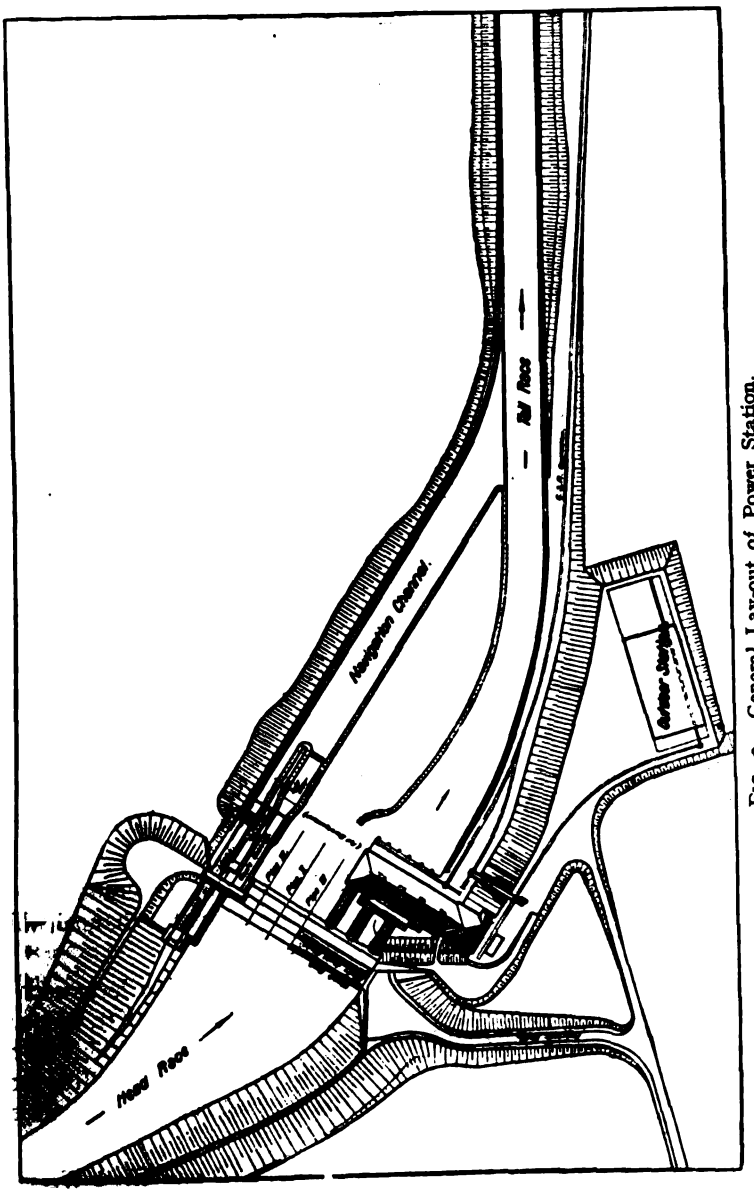

FIG. 9.—General Lay-out of Power Station.

comes for full development. The dam is 123 ft. high, about 300 ft. long, and contains over 2,000,000 cubic ft. of concrete.

Grouting of the rock was carried out here in the same way as at the weir.

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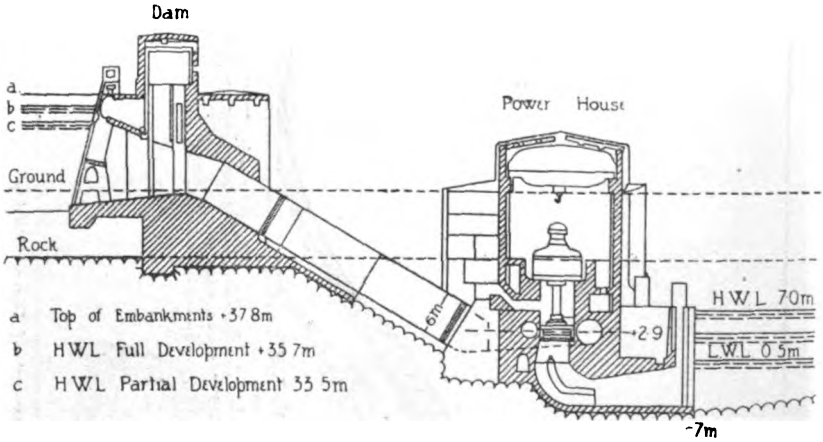
(*c*) *Penstocks.*—Separate penstocks are provided for each turbine, they are steel pipes nearly 20 ft. in diameter, with bell-mouthed openings, each closed by means of a roller sluice-gate, and guarded by a trash rack. The gates can be closed, if necessary, in 30 seconds, either from the bridge immediately above them, or from the power-station. An automatic mechanism will be connected to the turbine governor and arranged to close the gate should the speed of the turbine exceed a certain pre-determined maximum. The penstocks



Sectional View of Dam and Power House in the river axis

FIG. 10.

terminate in a spiral steel housing embedded in concrete, from which the water is fed direct to the guide vanes of the turbines (see Fig. 7).

(*d*) *Waste-Water Channel.*—Regulation at the power-station end of the head canal is obtained by a special waste-water channel, which has been built at the east end of the dam.

(*e*) *Locks.*—Adjacent to this are the two navigation locks each to lift ships of 150 tons a height of 55 ft. The locks are 18 ft. wide and 1,050 ft. long. The original intention was to instal a ship-lift for the whole drop of 110 ft. Certainly ships would have been lifted more quickly, but the total navigation at the present time is not sufficient to make this an economical proposition.

(*f*) *Turbines.*—Three turbines (two Voigt and one Eiser-Weiss) of 38,600 h.p. each, are being installed for the partial development, and three more of the same size will be added for the full development.

Each turbine is directly coupled by means of a vertical shaft to a

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30,000 kw. alternator, generating electrical energy at 10,500 volts.

The thrust bearings of the turbines are designed to take a maximum load, including the water pressure, of 480 tons; these bearings are fixed, one immediately over the turbine, and the other, which is a smaller one, over the alternator. The weight of each runner and shaft together is approximately 42 tons.

(*g*) *Overhead Cranes.*—The heaviest single piece of machinery in the power-station weighs 120 tons. Two 100-ton overhead travelling cranes are being installed in such a way that they can be coupled together for loads greater than their rated capacity.

A permanent broad-gauge railway line will run from the Great Southern Railway at Long Pavement right into the power-station.

(*h*) *Draught Tubes.*—The water is led away from the turbines into the tail race by means of reinforced concrete draught tubes. These tubes have a curved longitudinal axis, and gradually change from a horizontal circular section of 15·8 ft. diameter at the turbines to a vertical rectangular one 4·26 x 16·5 ft. at their outlets, 59 ft. away from the centre line of the turbines. The erection of the shuttering proved to be an interesting problem. It was temporarily supported on heavy timber frames, which were gradually replaced by concrete supports. The problem was further complicated by each draught tube having to be bisected by a steel-edged reinforced concrete vane in the elbowed portion (see Fig. 10), which is necessary to prevent whirlpool action. The placing of the reinforcement of this vane is shown in Fig. 11.

IV. The Tail Race.

(*a*) *General.*—In order to reduce the velocity of the spent water, the first 130 yds. of the tail race is sloped up from -7 to -3 metres. The remainder of the bed is practically level to the point where it rejoins the Shannon a mile away. The cross-section of the tail race is designed so as to prevent the current from exceeding 5 ft.-sec. when the tide is normal, so that navigation may not be impeded. In the partial development it is 69 ft. wide. The full development will require a width of 138 ft.

For nearly the whole of its length it runs through rock. This is composed of hard limestone and sandstone, partly interspersed with water-bearing fissures.

(*b*) *Explosives.*—For blasting dry bore-holes ammonal is used, and for those under water ammoniated gelignite. The explosive store is a large isolated and detached hut some distance from the works, and there is also a small detached detonator store. Both these buildings

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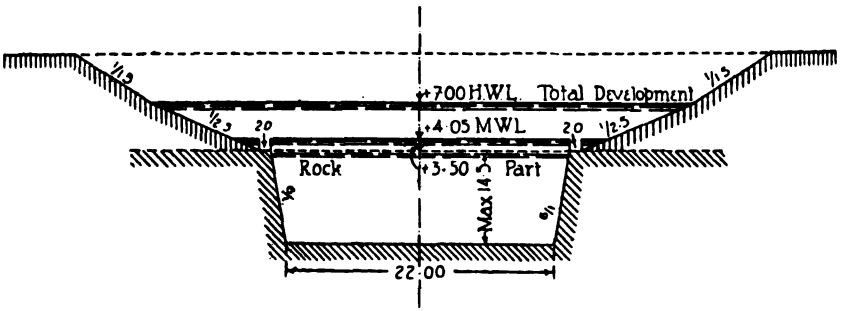
are underground. They are surrounded by banks of earth and barbed wire, and are under constant military supervision. Both powder and detonator stores are constructed of timber framing with cement walls. The inner timbering is separated from the walls by a 4" layer of air. The floor is constructed on the same principle. The roof is composed of slates lined with ruberoid. The buildings are also well protected against lightning by means of numerous conductors.

Blasting is done in both big and small bore-holes. Compressed air drills are used for the small holes, which are 1½ inches in diameter and of varying lengths, according to the nature of the rock.

(*c*) *Big Bore Blasting.*—Blasting by the big bore-hole method has proved to be very successful. It is found that three bore-holes of 8" diameter at 24-ft. interval are sufficient for the whole width of the tail race (69 ft.). To expedite the work, a second row of three bore-



Cross Section through the Tail Race.

FIG. 12.

holes is sunk at the same time 24 ft. further back from the face of the cliff.

The explosive is lowered into the bore-hole and rammed with a heavy rod. The primer with the detonator is placed on top of the charge. The whole is then tamped with wet clay and fired electrically. Electric firing effects a considerable saving of explosives, as it ensures a simultaneous detonation of all six charges.

Fig. 13 shows the Belgian boring machines at work.

V. ELECTRICAL TRANSMISSION AND DISTRIBUTION.

Electrical energy will be generated at 10,500 volts in the power-station at Ardnacrusha.

Immediately outside the power-station it will be stepped up in an outdoor transformer-station and fed into overhead high-tension transmission lines.

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The 110 kilo-volt lines form the primary transmission system; a three-phase line of six conductors will run from Ardnacrusha to Dublin, distance of 116 miles, and a single three-phase line from Ardnacrusha to Cork, about 59 miles.

The 38 kilo-volt lines form the secondary system, which is fed by three 110/38 kilo-volt transformer sub-stations at Ardnacrusha,

FIG. 14.—Map of Distribution System.

Dublin and Cork. The secondary system has been planned to provide loop distribution as shown in Fig. 14.

The tertiary system will consist of 10 kilo-volt lines, which will be supplied by transformer-stations at each of the places marked on the map (Fig. 14). The 10 kilo-volt lines are not shown, as their exact location has not been definitely settled.

Final distribution will be from 10,000/380/220-volt transformer-

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stations situated in every town and village, by means of three-phase supply at 380 volts for power and 220 volts for lighting.

Construction.

(*a*) *Supports.*—A maximum span of 820 ft. has been selected as the most economical for the 110 kilo-volt transmission lines, and 650

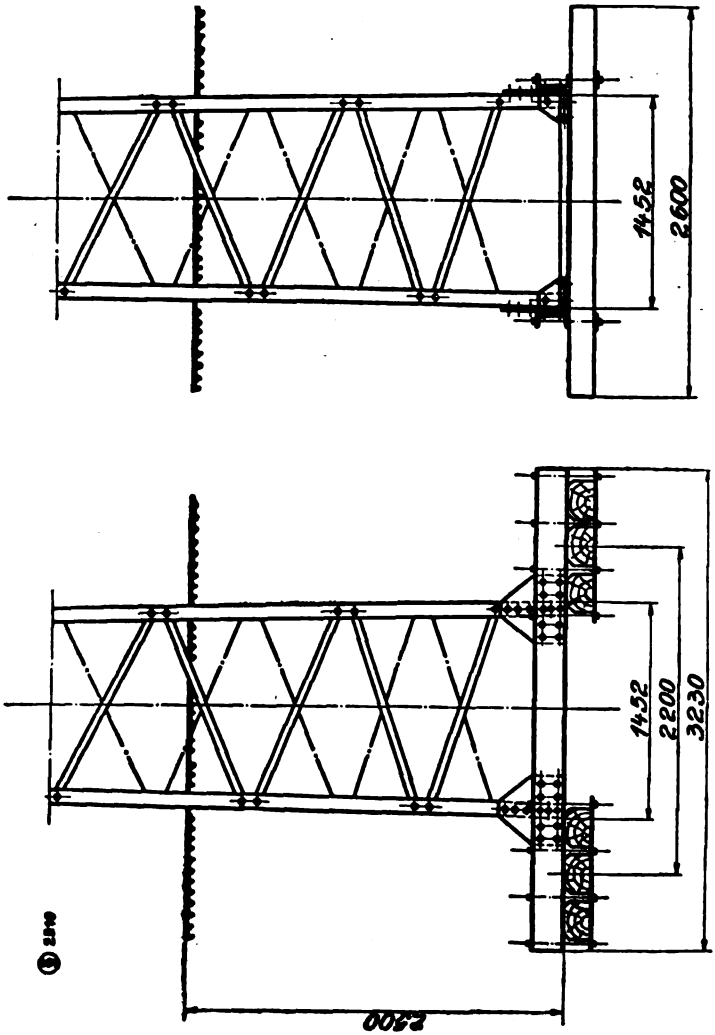

FIG. 15.—Foundation Structure of Intermediate Pole.

ft. for the 38 kilo-volt lines. The minimum clearance of the lowest point in the span of the conductors above ground level has been taken as 24 ft. for the 110 kilo-volt lines, and 22 ft. for the 38 kilo-volt lines. Road and railway crossings 24 ft. on all lines, and crossings over telephone wires at least 6 ft. clear.

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Fig. 19.—Normal Insulator Chain and Suspension Clamp.

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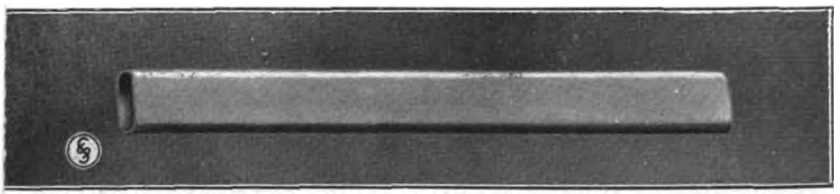

Fig. 17.—Jointing of Conductors.

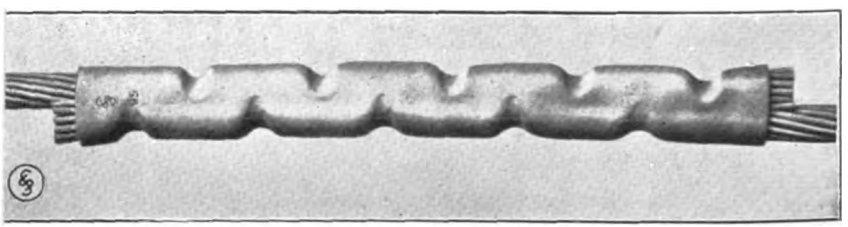

Fig. 18.—Connector in position.

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The normal pole sizes are as follows :—

	Height above ground.	*Depth below ground.*	
	Feet.	Feet.	Inches.
110 kilo-volt 6 conductor lines	70	8	6
110 kilo-volt 3 conductor lines	61	8	6
38 kilo-volt lines	49	6	9

The 110 kilo-volt lines are built entirely on lattice steel masts, while the 38 kilo-volt lines are built on lattice steel masts in the southern area and on wooden poles in the northern. For the 10 kilo-volt lines wooden poles are used throughout.

The lattice poles are set on wooden sleepers, fixed to channel irons on the pole base. The sleepers are impregnated with tar-oil and the ironwork underground is treated with hot asphalt tar.

The normal cross-section of the lattice poles is square (Fig. 15). No stays or struts are used. But angle poles are about twice the size of ordinary poles. They are sunk to a depth of 10′ 6″ below ground level, and double-braced to an extra heavy foundation.

(*b*) *Conductors.*—A very ingenious type of suspension clamp is used for fixing the conductors, it is made of gunmetal and fitted with a copper inset thimble which protects the conductor as shown in Fig. 16.

The conductors themselves are hard drawn copper cables with an ultimate breaking strength of 25 tons per sq. inch. The 110 kilo-volt line is wired with 0·147 sq. inch stranded cable, and the 38 kilo-volt line with 0·0775.

For exceptionally long spans on the 38 kilo-volt lines, 37-strand bronze conductors 0·147 sq. inch are used. These have an ultimate tensile strength of 6½ tons.

The jointing of conductors is done by means of groove connectors (see Fig. 17). These connectors give great mechanical strength combined with low electrical resistance. The breaking strength for the 0·147 sq. inch connector is approximately 3·7 tons, and of the 0·0775 connector nearly two tons, which is practically equal to the breaking strength of the conductors themselves. Fig. 18 illustrates one of these connectors in position.

(*c*) *Insulators.*—The conductors are supported by chains of seven and two suspension insulators for the 110 kilo-volt and the 38 kilo-volt lines respectively. The insulators employed are identical. They are designed for a dry flash-over at 450 kilo-volt per seven insulators, or 150 kilo-volt per two insulators, and for a wet flash-over (rain three mm./mins. at an angle of 45°) at 338 kilo-volt per seven insulators or 123 kilo-volt per two insulators. Fig. 19 illustrates the normal insulator chain and suspension clamp for 110 kilo-

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volt line and Fig. 20 the terminal insulator chain for 38 kilo-volt line.

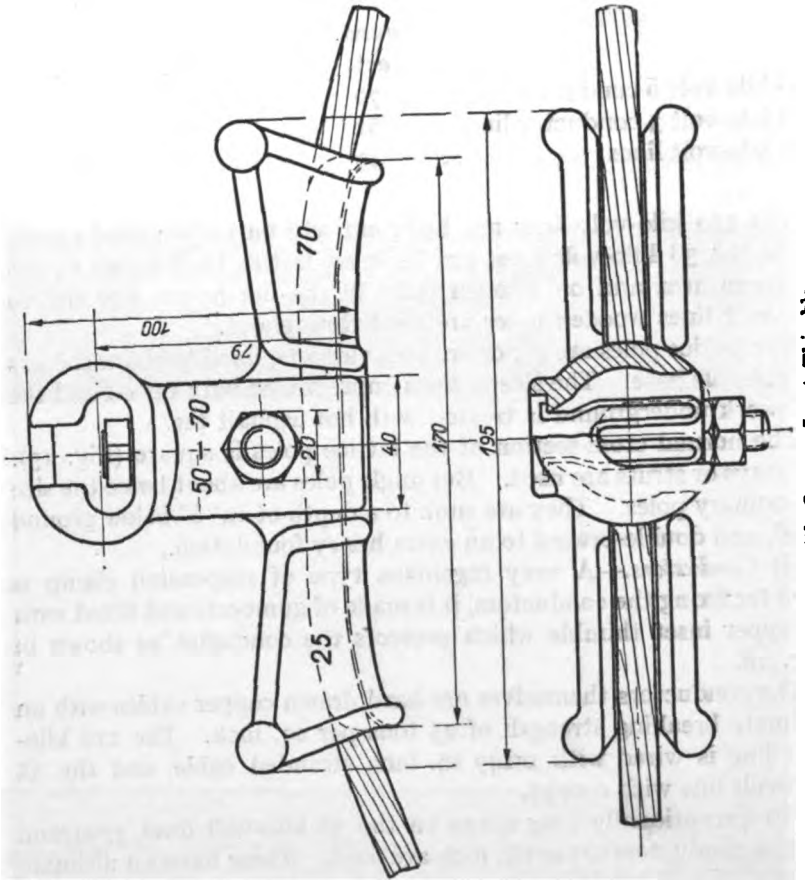
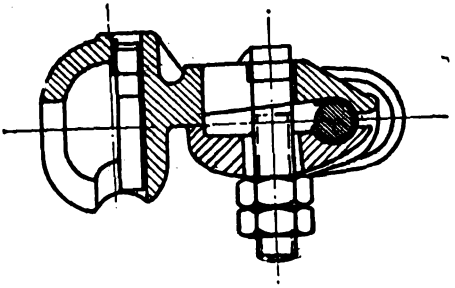


FIG. 16.—Suspension Clamp with Copper Inset Thimble.



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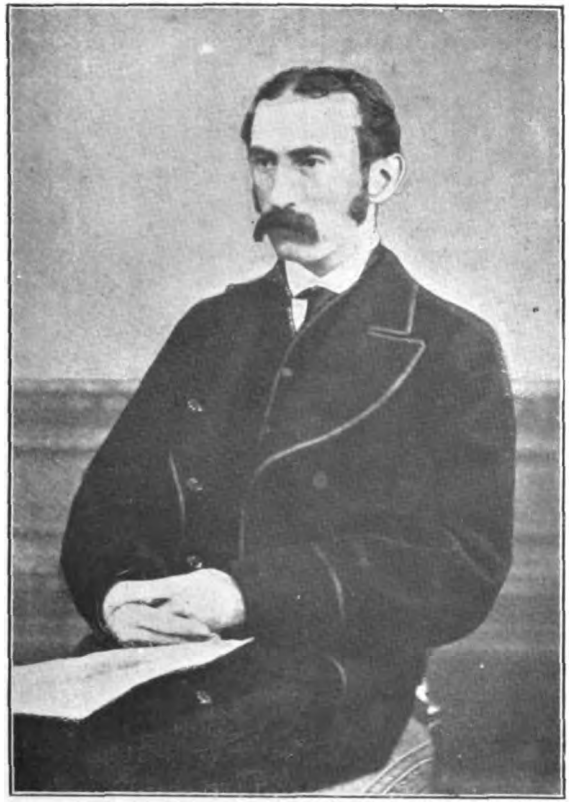
Lieut. R. H. Williams, R.E.,
Aged 25 years. November, 1866.



Lieut. R. H. Williams, B Troop, R.E.,
Aged 30 years. Date 1871 to 1872.

From a photograph in the R.E. Mess, Aldershot

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MEMOIR.

MAJOR RICHARD HARRY WILLIAMS.

Foreword.

PERHAPS some apology may seem needed for adding to the Records of the Royal Engineers a Memoir of one who never rose above the rank of Major, and who retired over 40 years ago, with no record of war service to his credit, or of deeds that catch the eye.

I plead, however, in defence, that Richard Harry Williams, a shining example of the Christian soldier and gentleman, was enabled through force of circumstances to exercise by example and precept a wide and abiding influence on many men, some of whom were destined to rise to high positions in the national service, and that, in this way, his life work exceeded in essential value that of many with much more brilliant professional records.

An officer of another branch of the Army, in talking of the late Sir Ronald Maxwell as a "white man and a sahib," said to me that the production of such men was by no means unusual in the Corps of Royal Engineers. This was a very high compliment, which we must do our best to deserve: however that may be, among our white men and sahibs the subject of this Memoir deserves a very forward place.

H. M. LAWSON.

RICHARD HARRY WILLIAMS, born at Chatham on May 20th, 1841, was a son of the Corps: his father, Montgomery Williams, joined the Royal Engineers a few months before Waterloo, and served in it in many capacities: he became a Major-General in 1860, a Colonel Commandant in 1867, and a full General in 1872, in which year he died, on the 18th June. He was buried in the churchyard at Findon, in Sussex, where some years previously he had settled down in a cottage, which later on was to be his son's home on retirement.

Harry Williams was the youngest of four children; the eldest, Caroline Amelia, married Major-General Lewis Frederick Hall, R.A., himself the son of a General, R.E.; the second, Rose Alexandrina, died unmarried in 1911: the third child, Sydney, served in the Royal Marine Artillery, and died in 1881.

Williams and his sister's children were mutually devoted, and to one of them the writer is indebted for material and information, without which this Memoir could not have been written. Williams

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got his first commission in October, 1858, too late for the Crimea and Indian Mutiny, but as a Cadet he marched past Queen Victoria, when she visited Woolwich on March 13th, 1856, to welcome her soldiers returning from the Crimea.

After completing his courses at Chatham, Williams served in Ireland for 2½ years, and then joined the 22nd Company, R.E., which, under the command of Major Edwards, embarked at Portsmouth on August 1st, 1863, for Hong Kong.

After the lapse of years, it is difficult to get testimony as to the Williams of his boyhood and younger manhood, but it is possible to glean something.

He was artistic from the first, a beautiful draftsman, illuminator, and water-colour artist; he had a wonderful ear for music, which enabled him, without any instructed knowledge, to pick out tunes on the piano and organ, and made it possible for him, on many occasions, and for extended periods, to perform the duties of organist in church. The religious instinct and belief, which was the guiding and predominating feature in his life, must have been of early growth, and, from the first, seems to have developed on definitely High Church lines. There is in existence a most beautifully illuminated book of the Holy Eucharist, done by him, and given to his sister, in the year 1860, on which is stamped his school of thought, and whose workmanship is a crowning proof of Williams' talents as an artist and illuminator. His love of architecture evidently developed at the same early period, and there can have been few men of his time better versed in the art, more especially in regard to Church architecture; we shall find later that, on more than one occasion, he took a very real and successful hand in Church restoration and decoration.

He was of about medium height, of rather poor physique, and as someone writing of his early days describes him, "rather pale and delicate looking, so kind and courteous." He doubtless had, what we who knew him in later years always recognized, something magnetic about him in his sympathy for others, and his power in getting on terms with them; he had also the quality, given to some, of raising those in their company, at any rate for a time, to their own moral and spiritual level. He was a very good conversationalist, full of humour and cultivated to a degree: his own modesty and, in later years, his feeling of growing deafness, made him retiring, but those who knew him best realized how calculated he was to shine in any company. He was generally very well read, and, lastly, he wrote in a beautiful hand a surprisingly good letter, so descriptive, so conversational, so lighthearted, and yet so interesting.

He maintained this latter quality to the end, and my wife, who never knew R.H.W. except through his letters to me, would never miss them when they came; in them there was the same attraction which we, who knew him personally, found in his company.

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To return to our narrative, the hired transport, *Louisa*, a sailing vessel of 902 tons, conveyed the 22nd Company, R.E., to Hong Kong: it took two and a half months to reach the Cape, and the same time to get from the Cape to Hong Kong. It must have been very rough travelling in those days, judged by modern ideas, and the mortality of women and children recorded in Williams' journal sounds deplorable. Williams took a hand in the Sunday services, organized the choir, and gave lessons in geography to those who wished it.

Arrived at Hong Kong, he seems early to have found favour with the Governor, Sir Hercules Robinson, for when the latter was transferred to Ceylon a few months later, he was very anxious to have Williams on his staff: things went so far that Williams followed Sir Hercules to Ceylon, in the hope of being allowed to take up the duty, but the War Office was obdurate, and Williams had to return to Hong Kong.

His journal shows how much Williams enjoyed life in Hong Kong (January, 1864, to July, 1866), and he made great friends there with Duncan Davidson, about two years his junior, who was employed for some years in one of the business firms at Hong Kong. Davidson was a wonderful athlete, and excelled at every description of sport and game, and he combined this with deep religious views; he and Williams attended many a church service together, and great was the grief to both, when, in April, 1866, illness caused Williams to be invalided home. This early friendship illustrates the attraction which those who were proficient at games and sport exercised on Williams, and one finds the same trait in later years, at Sandhurst, when so many of his "war pups," as he called them, were the recognized leaders of the cadets in athletics.

When Williams got home, he found his father, mother, and sister living in the cottage at Findon that some of us got to know so well in later years, and we find him taking up at once, with great vigour, the restoration of the parish church; later on, he paid a much appreciated visit to his friend Duncan's family at Inchmarlo, Aberdeenshire, where he enjoyed the friendly welcome, the lovely scenery of the Dee, and the interesting glimpse of Queen Victoria and her family, when presented to them at Aboyne.

A photograph of himself which Williams sent to his friends at Inchmarlo two months after his visit there, is reproduced, thanks to the kindness of Duncan Davidson's sister, Miss Davidson, of Inchmarlo Cottage, to whom the writer is also indebted for most helpful information.

At the conclusion of his sick leave, Williams joined for duty at Dover in December, 1866, when he found himself under the command of Sir Frederick Chapman, and where he did regimental duty until moved to Canterbury in January, 1868.

At Canterbury, Williams came in touch with a valued friend, Lieut.

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Blood (now General Sir Bindon Blood, G.C.B.), about two years his junior in the Corps, and it is characteristic that Williams' parting present to Sir Bindon, when the latter sailed for India in the early 'seventies, should have been a copy of *The Imitation of Christ*, by Thomas à Kempis.

In this period, Williams seems to have been very much in touch with some of the leading High Churchmen in the country, including Doctor Pusey, whilst he also lent an effective hand to the decoration and restoration of several churches.

When the work at Findon was finished, he took a prominent part in the restoration of St. Nicholas' Church, Sturry, near Canterbury, where much of the mural decoration was done with his own hands. His journal records many visits to Sturry, and the work appears to have been finally completed when he went to Sturry in January, 1874, to hang the chancel gates, and subsequently to meet his old friend, Duncan Davidson, who was home from abroad, and on his honeymoon.

Bowers Church was another one which he helped to restore, and we read that on September 14th, 1868, he commenced painting the roof of the chancel.

A change in his life came in the early summer of 1870, when he joined the 31st Company, R.E., at Shorncliffe, and went with it to Chatham in the August of that year. Here we find mention of another great friend, G. W. Tisdall, then in C Troop, and of whom Sir Bindon Blood speaks as the greatest friend he ever had. The friendship between Williams and Tisdall was obviously very close, too, and Williams saw his friend off, in November, 1871, to India, where Tisdall died in the following summer.

Early in January, 1871, Williams embarked with the 31st Company for the Curragh, but on the 19th of the same month he joined B Troop at Aldershot, where he was destined to stay, with some intervals at Chatham, until September, 1872.

ALDERSHOT IN THE EARLY 'SEVENTIES.

The Aldershot to which Williams went in 1870 was so unlike that of to-day, that it seems worth while to try and indicate the difference, and to record, however imperfectly, what the old hutted camp of the 'seventies was like.

In thinking of the Aldershot of those days, it is well to realize, to begin with, that, unlike the present camp, it could be, and under certain conditions was, a very dusty place. It bore a reputation in this respect which was thoroughly well deserved. Everyone used to talk of Aldershot being dusty, and with reason. The copses which now protect the camp on the west from wind and dust, were only then being planted, and where are now the grassy recreation grounds

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along the Farnborough Road, were then tracts of sand and heather: the broad grass strip which now divides Gibraltar and Buller Barracks from those to the south, and which adds so much to the attractiveness and spaciousness of the present camp, was then a mass of huts. In fact, all the ground from the Canal, between the Farnborough Road and the central power-station, to the high ground overlooking the permanent barracks, was covered with huts, with the exception of a small recreation ground, north of the Officers' Mess, Barossa Barracks, and of an infantry brigade parade ground lying south of a line from the site of the present Central Gymnasium, to the top of Gun Hill Road.

The picturing of the camp in more detail is facilitated by realizing that the roads which served it still remain, widened and modernized, but then without their present names. Thus, the great central artery of the Camp, the present Queen's Avenue, was in those days called Middle Road, but it bore little resemblance to the spacious thoroughfare of to-day. The then roads were narrow, highly cambered, and flanked by deep gutters, whilst at road junctions white posts served to show the way at night, and to keep vehicles out of the ditch.

The huts themselves ran in rows parallel to the Farnborough Road, the most westerly row about 130 yards from that road. They were divided into 24 sections called "Lines," lettered from A to Z, omitting J and U. Each Line covered a space of about 170 square yards, and was placed on either side of a north and south road, on the west side of which were two rows of men's huts, 24 in number, and on the east side were the Officers' Mess and quarters, with various accessories. West of the soldiers' huts in each Line was a gravelled space about 70 yards wide, separating the Line from its neighbour to the west and serving as a company and battalion parade ground.

The present east and west roads divided the Lines from one another longitudinally, whilst the north and south roads, which ran down the centres of the Lines, still exist in Mandora Road, Fire Station Road, Maida Road, Queen's Avenue, Barossa Road and Albuera Road; the only one of these which is not complete to-day is the most westerly one, which does not cross the Green Parade Ground, but is taken up at its northern end by the road that runs north between the R.E. Mess and Burgoyne House.

The huts, some red, some black in colour, and with tarred felt roofs, were placed somewhat close together as judged by modern standards, whilst the diminutive spaces between them were encumbered by iron folding screens on travelling carriages, to be used for isolating burning huts in case of fire, as well as by frequent clothes lines, on which garments as well as pipeclayed belts and gloves hung out to dry; all this, helped by the narrowness of the roads, served to give a general impression of congestion.

As regards the location of the various Lines, the present Green

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Parade Ground accommodated six of them, viz., B, F, L, P, T and Z; Albuera, Barossa and Corunna Barracks are on the site of 5 Lines, viz., C, D, G, H and M; Maida Barracks and the adjoining Married Quarters stand on the ground once occupied by M, Q and V Lines, whilst Gibraltar Barracks are where A, E and K Lines used to be; the site of the remaining Lines, which stretched as far north as Transport Road, is to-day covered by married quarters, C and D squares, Buller Barracks, and part of Mandora Barracks.

The Command Headquarters were at the south end of the camp, in the present needlework hut, and looked out on to the infantry parade ground, whilst south of the Prince Consort's Library, in rather attractive wooded, undulating grounds was what had once been the hut residence of the Commander-in-Chief, but which was later the abode of one of the Infantry Brigade Commanders.

Taking in more detail the Royal Engineers, who were located in K, I and N Lines, let us start a few yards west of the present Command Headquarters, where the Queen's Avenue crosses Steele's Road. This point marked the southern end of K Lines, which ran down on either side of Middle Road (now Queen's Avenue), as far as Alison Road, beyond which I Lines began and continued down to the R.E. Yard and Transport Road. The Third R.E. Lines, N Lines, was the next Line to the east of I Lines, and extended on either side of the present Maida Road, from Alison Road to Transport Road.

Commencing again from the starting point, and looking towards the Canal, the men's huts in double row extended down the left side of Middle Road, the western flank of the K Lines huts being now marked by the eastern ends of the Gibraltar Barracks Blocks, whilst those in I Lines occupied part of the present R.E. Parade Ground.

On the right side of Middle Road, again looking towards the Canal, there were in K Lines, besides some miscellaneous huts, three Officers' Married Quarters, the most northerly one being the C.O.'s hut, with its entrance on Alison Road.

Opposite to the C.O.'s hut, on the other side of Alison Road, was the southern end of the R.E. Mess Compound, with a front on that road of about 30 yards.

The western side of the compound ran along Middle Road, but standing a little back from it, with some servants' huts in between, and its northern end was just north of the west front of St. George's Church. Beyond the compound again were some miscellaneous huts, ending with the school facing Transport Road, and looking across to the iron church a few yards nearer the Canal.

The R.E. Yard was then where it is now, and in lay-out was very much the same as at present, save that the stables and offices were in wood, and not in permanent material.

The Parade Ground, smaller than at present by the space occupied by two rows of huts, served for foot drills, and for occasional demons-

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trations of the complicated wagon drill of the day. There was a flavour of unconscious humour about the old order, " The Line will *Retire*," when its first consequence was the command " Right Half Sections will *Advance*."

The formation of N Lines was the same as I Lines, and, like I Lines, provided three Married Officers' Quarters for the Royal Engineers.

There is a particular interest attached to No. 3 Hut, N Lines, which stood close to where is now the Serjeants' Mess Enclosure, of D Square Married Quarters.

It was the usual residence of the Commander of the Pontoon Troop until its last days, when it became the home of the Adjutant.

The hut is chiefly famous, however, because for a period it was occupied by Major and Mrs. Ewing, of whom more is written later in the Memoir.

The R.E. Mess and its surroundings now demands attention.

The Compound was surrounded by a substantial holly hedge, six to eight feet high, with red may trees at intervals, a barrier to dust and dirt from the outer world.

It contained within it, at its southern end, the Mess, with its back to Middle Road, whilst north of the Mess were three officers' huts, each with four quarters so tiny that the occupant could close the door, open the window, and poke the fire without getting out of bed.

Inside the holly hedge in front of the Mess, round the officers' huts and to the north of them, was the much prized and cared-for garden, with its flower beds of true Victorian type, gay with colour in the summertime, and its well-kept paths and carefully mown grass borders.

The main approach to the Compound was from the East, and opposite to the Mess. A visitor passed through the hedge by a wicket gate, and a few yards along a rustic passage brought him to an entrance door and hall. To the left of the Hall was the low but spacious ante-room, with an attractive bow window: beyond the ante-room was the billiard-room, alongside of which lay the Mess Room, where at an inspection dinner as many as forty have been known to sit down.

Another entrance to the Mess led from the garden through the conservatory, an important factor for the garden, and under charge of the officer on whom the care of the garden devolved.*

The married officers' quarters, gay with creepers and tiny gardens, were small when judged by modern standards, but they managed somehow to accommodate considerable families, and to give scope for much modest entertaining, and a pleasant social life.

* *Note.*—The standard of comfort in the Infantry Officers' Messes fell considerably short of the above. The accommodation consisted of two ordinary huts, one for a Mess Room, and one for an Ante-Room; a road separated the two huts and, without any covered passage, the crossing to and fro on a wet or stormy night presented obvious difficulties.

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They seem to have made comfortable homes, even though their walls did let in the frost in winter and the heat in summer; happy lives were undoubtedly lived in them, and some officers passed most of their service in these unsubstantial structures.

Aldershot had an attraction then for the R.E. which it does not now possess; at any rate, not to the same extent. It was the home of the Train, containing the only mounted units which the Corps possessed; it drew to it the type of officer who loved soldiering, was fond of horses, liked to wear a scarlet stable jacket, or was attracted by the glitter that undoubtedly appertained to the Train. Officers used to go on there from billet to billet, or return thither after short intervals. In this way there was a continuity established, and a similarity of outlook, which brought about a camaraderie among officers of the Train. It made Aldershot, so far as the R.E. were concerned, a very pleasant home.

Whilst Williams served at Aldershot, that fine old Scotch soldier, Sir Hope Grant, commanded the division, and among his staff were Sir Archibald Alison and Colonel Evelyn Wood. The C.R.E. was Colonel R. M. Laffan, later on Sir Robert Laffan, Governor of Bermuda, whilst another Corps celebrity, Colonel FitzRoy Somerset, commanded the R.E. Train, with Sir Arthur Mackworth as his Adjutant. The A Troop was commanded by Captain Micklem, B Troop by Captain Durnford, and the newly-raised C, or Telegraph Troop, by Captain Lambert, with R. M. Jelf as one of his subalterns.

To Laffan the thanks of successive generations are due for the way in which the Government land was laid out, and planted with its various woods and copses. Many years later, Sir Evelyn Wood, when in command at Aldershot, perpetuated the memory of the C.R.E. of those days by giving to the principal review ground the name of Laffan's Plain.

Williams got to know Evelyn Wood very well, and they became fast friends. Although differing in some respects, they had the same fundamentally deep feeling for religion, and the same healthy, high-minded and progressive outlook on life. Wood was just the man to appreciate Williams' character and to realize what an asset such men were to the Army.

In later years they used to correspond, and, when Williams was an Instructor at the R.M.C., Wood used always to invoke his aid towards getting cadets of promise for his regiment.

This was a period of renewed activity in the Army, the short-service system had just been introduced, and the Franco-German War had led to the first army manœuvres of 1871 and 1872, the former in the vicinity of Aldershot, and the latter round Salisbury Plain. Williams' journal tells us of the part which he and " B " Troop played in those mimic campaigns, and reflects the professional zeal just then awakened in officers of the Army.

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The only church in the South Camp at this period was the iron church, or " Tin Tabernacle," as it was sometimes called. The iron church, which was always what is termed a temporary structure, was first erected in the late 'fifties and placed east of the camp near Thorn Hill, close to the Dust Heaps, sandy tracts where the Artillery and the Army Service Corps used to teach their recruits to ride and jump. In thee arly 'sixties, mainly at the instigation of Dr. Edgehill, it was moved to a more convenient spot, viz., to where the Presbyterian Church of St. Andrew now stands, and there it remained until a couple of years ago, when it was pulled down and replaced by the permanent building which now adorns the site.

From its earliest days up to 1893, when St. George's Church was consecrated for the exclusive use of the Church of England, the iron church was used for divine service by Church of England, and Presbyterians, and sometimes by other " Persuasions " as well.

After 1893, the iron church was allotted in the main to the Presbyterians, and it was at their request that, in 1907, the iron church lost its old title and became St. Andrew's Church.

The iron church, where they always worshipped, had a very special attraction for the Aldershot Engineers. They had built it originally, and, later on, had moved it to its new site. A famous Army chaplain, Dr. J. C. Edgehill, later Chaplain-General, was for two periods of service their pastor there. They loved him, and that made them love the more the church wherein he preached. In this way, a succession of officers and men became devotedly attached to the " Tin Tabernacle," unsightly though it was, and many an Engineer Memorial was placed therein.

The iron church found its way into literature, more especially into one of the best known of Mrs. Ewing's stories. There were many heart pangs when, in the fullness of time, the death sentence was passed, and a building hallowed by many a sacred memory ceased to exist.

Williams was one of the many who loved the Tin Tabernacle: he was a constant worshipper there, helped in the choir, and on many occasions played the harmonium at the voluntary services. He had a deep and lasting affection for Dr. Edgehill, and more than once assisted him in the efforts he was making for placing the Chaplain's Department, and all that appertained to it, on a more satisfactory basis.

A counter-attraction to Dr. Edgehill, although not probably one that appealed to Williams, was the Rev. Charles Kingsley, the Rector of Eversley; on Sunday mornings not a few from the camp used to ride or drive over to hear him preach in his little country church, and get a subsequent glimpse of the glories of Bramshill.

The story of Edgehill's first rise to fame was often told the writer by Williams, and just recently, July 1st, 1928, the incident was

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referred to by the present Chaplain-General, on the occasion of his unveiling a window at St. George's Church, Aldershot, to Dr. Edgehill's memory.

Edgehill was a man of somewhat High Church tendencies, which were anathema to the then Commander of the Aldershot division. Rumours reached Sir Hope Grant of a Communion Table recently introduced, which was high in two senses of the word. In one of his morning rides, Sir Hope inspected the table, sent for an R.E. carpenter, and had the length of the legs summarily reduced. Edgehill, naturally, was furious; he resigned his appointment, and announced the fact from the pulpit on the following Sunday. The R.E., to a man, were with their beloved pastor, and the camp hummed with excitement. Edgehill stood his ground, the Duke of Cambridge came down to inquire, supported the Chaplain, and was so struck by his qualities that he never again lost sight of him, and in course of time appointed him Chaplain-General.

There was at this time living in the Commissariat Lines, and later, as already stated, in one of the R.E. married officers' huts, No. 3, N Lines, the lady who, by her books, did so much to keep alive the memory of the Aldershot of those days, Juliana Horatia Ewing.

Her husband, Major Alexander Ewing, was for many years an officer in the Army Pay Department. A man of many parts, and a talented musician, his name will always live as the composer of the well-known music of "Jerusalem the Golden." He was a well-known figure in the life of the camp, and for years played the organ in what is now called the Royal Garrison Church of Aldershot, but which was formerly better known as the "Red" Church.

He had great skill as a conductor and accompanist, and as such was indispensable at the various concerts and amateur performances in camp. He was a great friend to all who loved music, as many an officer who relied on his help and profited by his instruction could testify.

The Ewings had a long career at Aldershot from 1869 to 1876, and, endowed with a singular charm, were the valued friends of a succession of Engineers, married and single. He was a welcome member of the R.E. Mess, and in later years was equally at home at the R.A. and R.E. Mess in Malta.

Among their many admirers and allies, a principal place must be given to the Jelf family, father, mother and sons, whose names occur frequently in Mrs. Ewing's letters, and in the Memoir of her written by her sister, Mrs. Eden.

In the pleasant circle of those days at Aldershot Williams had his place, and with his love of music and art, and a kindred outlook on religion, he was numbered among the friends of Major and Mrs. Ewing.

In Mrs. Ewing's books there are numerous references to the camp

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and to the Royal Engineers, more especially in one of the most delightful and pathetic of them," The Story of a Short Life." This book also contains a sketch of a High Church Officer of Engineers, which, the Williams family have always held, was drawn from the subject of this Memoir; to the present writer the likeness seems unmistakable, Williams is drawn to the life. It is hoped that one result of this Memoir may be to introduce some of its readers to a series of delightful stories from the pen of a gifted writer.

His Aldershot days were indeed happy ones for Williams, and he was very fond of talking about them in later years. At Aldershot he made many a friendship, he loved his work, and its surroundings, whilst his soldierly smartness and military efficiency, so patent to all who knew him subsequently, were in no small measure due to his two years' service in the Train.

CHATHAM.

Williams was promoted to the rank of Second Captain at the end of June, 1872, and so at the close of the Army manœuvres of that year he was sent to Chatham, to take command of the 35th Company, R.E. He was also appointed Assistant Instructor of Fortification, a post which he held for just under a year, going to the R.M. College, Sandhurst, as an Instructor on September 1st, 1873.

The matter which is of chief interest regarding Williams' year at Chatham was his acquaintance with the future Lord Kitchener. A good deal is told in Sir George Arthur's volumes, but the writer got it first hand from Williams on many occasions from 1883 onwards, and long before Lord Kitchener reached his zenith.

The acquaintanceship commenced, as Sir George Arthur describes, by Kitchener bursting into Williams' office, and begging to be allowed to remain on in possession of the room which he had been just ordered to vacate, because it belonged to the quarter which had been allotted to Williams: the latter visited the room, crowded with all sorts of things, including a parrot, took a liking to the impulsive youth with a nice, persuasive manner, and so commenced forthwith a friendship that never ceased till death divided them. Williams joined at Chatham on September 27th, and we find an entry in his diary dated November 17th, " Evening Service at Rainham with Kitchener," and again, " Dec. 15th, Evening Service at Upnor with Kitchener "; as is said in Sir George Arthur's book, " In a week we understood each other, took our daily exercise in company, sat next each other at Mess, went to evensong together, and became inseparable."

From all accounts, the Kitchener of those days was not of much account among his contemporaries: probably because, unlike most of them, he never had a public school education, or acquired the public school attitude to things in general: he was more natural and outspoken than his fellows, and it was only later that he learnt, as it

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were, to wear a social mask to face the world with. But Williams was at once struck by the qualities of " John " Kitchener, as in those days he used to call him, and was the first in the army to appreciate the potentialities of the future saviour of his country: it was a remarkable bit of character reading, and a testimony to Williams' insight. One story which Williams often told me was how on one summer's day in 1873, " John " Kitchener came to him with an application to be allowed to attend the manœuvres in Austria, which were to be held that autumn; it was a strange thing for a young officer at Chatham to know anything about foreign manœuvres, and stranger still for him to imagine that he might be allowed to attend them. Williams explained to the impulsive John how useless it would be to send forward such an application; Kitchener, however, was persistent, and to please him, Williams backed the application, never imagining that it would even reach the War Office. The unexpected, however, happened, for not only did the request reach Headquarters, but in due course instructions came from London that " John " was to accompany a General Officer to Vienna. The story went on to say how the General fell ill on arrival at Vienna, and how frightened " John " was when the Military Attaché told him that he would have to sit next the Emperor at dinner—how Francis Joseph at once took to the lanky, eager boy beside him, helped him in every way, made him ride with him in the field, and how, when the manœuvres came to an end, the Emperor told Kitchener that he must never pass near his dominions without coming to Vienna to see him. The story shows the Emperor was no mean judge of character, and he shared with Williams the distinction of having " discovered " Kitchener years before he began to make his name. It would be interesting to know whether, forty years later, in the Great War, the old Emperor ever told the story of how he first met Kitchener.

In after years, Williams always spoke of his friend " John " in the terms of the greatest affection: his faith not only in his professional future, but in his sterling worth and the deep religious basis to his character, never altered.

Kitchener was posted to " C " Troop at Aldershot shortly after Williams became an Instructor at Sandhurst, and they collaborated over the improvement to the iron church: we read in Williams' diary of the dedication of the organ, on the same day that " John " said " good-bye," prior to joining the Survey of Palestine.

Kitchener never forgot the friend of his Chatham days, and always kept up with him, wrote him frequent letters, and, long after becoming famous, paid him many a visit at the Findon cottage.

The scene now changes to the Royal Military College, Sandhurst.

During his period of ten years at the College, Williams came under three Governors, Generals Sir Duncan Cameron, William Napier and Sir Richard Taylor.

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He served for 8½ years as Instructor under two professors of Fortification, Colonel G. Philips, followed by Captain E. C. O'Brien: he was professor for only eighteen months, and on leaving was succeeded by Major L. K. Scott, famous in rackets and cricket, and the inventor of the telescopic sight.

The cadets were organized at that time in divisions, very much the same as a company, and Williams was one of the six Instructors who lived in the College, where he commanded No. 5 Division. In this way, he was brought into very direct contact with those in his Division, over and above those in the classes which he instructed in fortification. Williams was known to successive generations of cadets as "Pie Bill." The name did not arise because he evinced any desire to approach cadets on religious topics, but rather because he showed in many ways how religious he was. It is not easy at a glance to tell a very devout Low Churchman, but it is different with the school to which Williams belonged, and anyone making the sign of the Cross at grace, as Williams always did, would be at once noticed by boys, and it was doubtless to the various signs of reverence, which a High Churchman adopts, that Williams owed his nickname.

A former Cadet, who knew him well, writes as follows:—"His "genuine piety was known and respected by all of us, even by those "who were themselves irreligious. It was evidently so perfectly "genuine, and at the same time unobtrusive, that he was always "spoken of with something akin to affection. His nickname was "'Pie Bill,' but his piety never aroused the opposition and dislike "which is often the result of the tactless and over-zealous introducing "of religion when it is not desired. He was wise enough to be friendly "and natural with cadets, to enter into their interests and amuse-"ments, and to wait for opportunities of speaking on religious and "moral questions. When such opportunities arose, he went straight "to the point, and anything he said was listened to and remembered. "As an illustration of his method, I recall the case of a wild young "Irishman in his division, who was in hospital suffering from venereal "disease. Williams went to see him, and spoke very seriously to him "on the whole question of the other sex. That this young fellow "was not vexed or annoyed or contemptuous, but told me with no "feeling of resentment all that Williams had said to him, surprised "me much at the time, and I have always remembered it as an "illustration of his courage and his wisdom.

"He had a knack of getting to know many cadets not in his "division, who religiously or morally were a little above the ordinary "level. We used to go to tea with him in his rooms, and sometimes "go up at night, and sit talking and smoking with him. He was, "as you know, a great smoker, and nothing of a pussyfoot, two things "which helped to endear him to us, and made for friendly conversa-"tion. I do not remember that he ever introduced religious questions

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" on those evenings, but he got to know our characters, and so to " know what he could say properly and without offence, when anyone " of us was alone with him."

It may be mentioned that the writer of the preceding interesting note first got to know Williams through devotion to games and athletics, at which he was a great proficient, because it illustrates what has been previously written about the attraction which skill at outdoor pursuits had for Williams.

Another cadet to whom Williams was devoted, now Lieut.-General Sir Thomas Snow, accentuates the tact displayed in not forcing religion on unwilling cadets, and writes: " I cannot remember any " instance when I was aware that 'Pie Bill' was thrusting religion on " one. I do remember that he used to get some of us to go to evening " service on Sundays, but he did it so well that I am not sure that " we did not think that we were taking him."

General Sir Archibald Hunter, who was a Sub-Lieutenant at Sandhurst in Williams' early days, viz., in 1874, writes as follows of him :—" He was a dear, good friend to us boys at Sandhurst, and " helped us in every way, not only with our work, but with our whole " life and thought. I have never met any officer in the army who " was more trusted, respected and beloved, than Major Williams. I " have a photograph of him among my treasures. He was a great " gentleman, a sincere Christian, and was a perfect model of what " we should all try to be."

It seems full of interest that Williams should have made, independently, such an impression at the very outset of their careers on Lord Kitchener and Sir Archibald Hunter, who were destined to work so much together, and to make such a mark on the history of our times.

There can be no question as to the deep and abiding influence for good which Williams exercised during his ten years at Sandhurst on a great number of young men at the most impressionable period of their lives; amongst these were many who subsequently rose to high distinction, and who have been ever ready to acknowledge the debt they owed to " Pie Bill." In his later years, Williams always spoke of his time at Sandhurst as the happiest and most fruitful in his life. The present writer himself has received abundant personal testimony as to what Williams achieved among the cadets, and in almost every case where he has come across in later years a Sandhurst friend of Williams, he has seemed to find, in a very nice and generally athletic fellow, something still remaining of the Williams ' touch.'

No mention of Williams' work at Sandhurst would be complete without a reference to the share he took in the internal decoration of the College Chapel.

The chapel, which was dedicated in 1879, was modelled in design on a church in Florence; built of brick, the design lent itself to a

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scheme of internal decoration of coloured marbles, on lines familiar in Italian architecture, and with special reference to the Cathedral of Siena. A scheme to this end was drawn up by Williams, and received approval.

There were to be at intervals special war panels of Derbyshire alabaster, inscribed in letters of gold, with the names of all those who had passed through the College, and who had lost their lives on active service.

At a higher level than and between the war panels, circular alabaster tablets were placed, with the names of past governors of the College. Above, below and around the war panels and the circular tablets, the walls were covered, as a commencement, to a height of about ten feet, with different marbles of varied colours, arranged in beautiful patterns, and with varied ornaments.

The scheme provided for the gradual decoration of the church on these lines, and its effect bore some resemblance to the internal decoration of the Guards' Chapel at Wellington Barracks, which was taken in hand about the same time.

Ten of the war panels were completed with the names of those who fell in campaigns from 1854 to 1890, and those who remember the chapel as it was, up to the outbreak of the South-African War, bear testimony to the beauty of the design, and of its effect when completed.

After the South African War, fresh arrangements had to be made for causes which need not be particularized, and the original design of decoration was not followed in its entirety. Later on, when the number of cadets in the College was largely increased, it became necessary to enlarge the chapel: the work was taken in hand after the Great War, and has not yet been completed. The method of internal decoration was changed to meet a new situation, with the result that the work which Williams initiated is only to be found in portions of the earlier building, and especially near the vestry door.

In the parts that remain of Williams' work, it will be seen that the names that were once coloured in gold, have been changed to brown. This was the result of action by the late H.R.H. the Duke of Cambridge, who at his various visits to the chapel did not like the gold lettering, because the names could only be read on close approach. This had been well appreciated by the designer, the gold harmonized with the marbles of various colours in the general scheme of decoration, and the last thing he desired was that the names should catch the eye, and distract the attention of the congregation. The Duke at last had his way: one day he visited the chapel with Sir Redvers Buller, and again commented on the fact that he could not read the gilded names from the centre of the church, and once more expressed the opinion that they should be painted black. Sir Redvers Buller, the writer is glad to know, opposed the suggestion of H.R.H., but

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when some ladies, who were present, came forward, and offered themselves to paint the names in black, royal and feminine pressure in combination proved too strong, and the dark deed, which from an artistic point of view was wholly indefensible, was put in hand.

On completion of ten years' service at the R.M.C., Williams, then a regimental Major of four years' standing, reverted to Corps duty.

A tendency to deafness had been coming on gradually during his Sandhurst years, and Williams, keenly sensitive in such matters, had doubts whether he was justified in continuing longer in army service. He consulted Sir Howard Elphinstone, then at Aldershot, on the subject, who, in the course of his reply, wrote—"As to your "slight deafness interfering with your work, I am satisfied that "this idea exists in your mind only and in no one else's! You "are in every respect more able to perform your work than 99 out "of 100 in our Corps, and I trust that you will drive such ideas from "your head as a duty which you owe not only to yourself but to the "Corps. We cannot afford to lose an officer of your stamp."

Fortified by such an opinion, Williams found himself ordered on Corps duty to Egypt.

He went in the early days of the occupation, and there was still a considerable British force of all arms in the country. General Sir Frederick Stephenson had just taken over command, an Engineer, Sir Gerald Graham, V.C., commanded the Infantry Brigade in Cairo, whilst General W. Earle had charge at Alexandria.

Williams found his old friend, Sir Evelyn Wood, as the first Sirdar, engaged in bringing into being the Egyptian Army: Kitchener was Second-in-Command of the Egyptian Cavalry, and Hunter had command of the Sudanese Battalion, which became so celebrated under him in stress of war. Sir Evelyn Baring, afterwards Lord Cromer, held sway at the Residency, and the disaster at El Obeid to Hicks Pasha, from which so much was to result, had recently occurred.

Colonel Heriot Maitland was C.R.E., with Captain A. O. Green as his Brigade Major, and the 17th and 26th Field Companies were at Abbassia and Cairo respectively.

Williams joined the R.E. Mess at Kasr-el-Nil Barracks, Cairo, on his arrival in Egypt, and when the writer came to Cairo shortly afterwards, he found Williams settled down, exercising a mild despotism over the Mess, but beloved by all its members. Some of us had got rather slack in our dress at Mess during the summer heat of Cairo, and Williams brought us back to better ways; he gently corrected our shortcomings, and raised our moral standards without any obvious effort: it was simply himself, his personality and example, that did the work. Then he helped to make Egypt, its history and its treasures, interesting to us, and visits with him to the mosques, the churches and the Bulak Museum, were instructive and

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delightful: he saw so much, had read so much, and had such a knowledge of art. The young officers at Abbassia and at Cairo were devoted to him, and many of them have confessed the lasting debt that they, like the writer, owe him for developing their tastes, and giving them a higher and better outlook on life. He was so friendly and brotherly to all, whatever their point of view, that he won everyone's sympathy and regard. He was in Cairo when General Gordon passed through on his last journey to Khartum. Williams had known Gordon well, and told us much about him, and he sent us to leave our cards on the General at the Sirdar's House. We never saw Gordon, but the writer well remembers the nice letter Williams had from him, expressing regret that he was unable to come and see his brother officers before he left for the south.

In February, 1884, disturbances in the vicinity of Suakin led to an Egyptian force, under Valentine Baker, being sent there, and, when that was overwhelmed, a hurriedly collected British Force was sent to Suakin under Sir Gerald Graham, and had severe contests with the Hadendowa Arabs at El Teb and Tamai. Williams was the senior regimental Major, R.E., in Egypt, and assuredly would have been sent with the Force as C.R.E. but for his deafness, which had materially increased since he had consulted Sir Howard Elphinstone about it. As a result of this infirmity, Colonel Ardagh, then on the staff at Cairo, but junior regimentally to Williams, was given the post of C.R.E., and Williams was left in Cairo. The decision in the circumstances was perhaps a right one, but Williams felt it keenly, although to us he never showed his mortification, and the writer remembers how helpful he was to those of us who formed part of the Force, and what wise advice and counsel he gave us. The incident, however, brought Williams' military service to an end; he felt that if he was not fit to go on active service, it was better for him to leave the army, and so his papers went in, and on May 27th, 1884, his military career came to an end, when he retired with the honorary rank of Lieut.-Colonel. He travelled home by Venice with one of the young brother officers who appreciated him most, and who has told the writer what a revelation it was to see the beauties of Venice in company with one who was so well able to appreciate and explain them.

Although Williams' life after retirement covered the same span, 43 years, as the previous period, it can here be only very briefly sketched.

He lived for 27 years, from 1885 to 1912, in the cottage at Findon which his father had originally bought.

Here he had as his companion his invalid sister, to whom he was devotedly attached, and of whom he took the most loving care until her death in 1911. He led a very quiet life, but did much unobtrusive

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good in the little Sussex village and its vicinity, and had a very attached circle of friends. When first he came home, he was much at Muntham Court, where Lady Bath lived: she had in her day taken a prominent part on behalf of High Church principles, and she and Williams had a similarity of outlook on all religious questions. Her death was a sad blow to him when it came in 1892, and he mourned her "as the truest and best of friends for over 30 years."

As the years went on, his deafness increased, and cut him off more than ever from general society: on account of this, and of the constant care which his sister required, Williams rarely left home. He enjoyed, however, the occasional visits of old friends, whilst he kept up with them and others by means of correspondence. His nephews were devoted to him, and frequently came to see him and his sister as long as the latter was alive. In 1912, shortly after the death of Miss Williams, a move was made to Dorchester, where one of his nephews was then residing.

Williams lived in lodgings at Dorchester until a couple of years before his death, when he moved to Taunton to be near the same nephew, who had finally settled down hard by in Somerset.

At Dorchester he collected more friends, and throughout the War and afterwards was a constant visitor to the Military Hospital, and was happy in helping as best he could those who stood in need of help.

Many stories of his unfailing kindness to the cripples of the War could be told if space permitted.

The evening of his life was wonderfully calm and serene: the writer several times visited him in his lodgings at Dorchester, where he lived in a very modest, simple way, and necessarily to a great extent alone. The dear old man was always bright and happy, and no one who was much with him could doubt that his was the peace that passes all understanding. His final days were spent at his nephew's home.

His mind gradually failed, and he lived over again his early years, and was constantly wanting to get back to Chatham, for fear of overstaying his leave. Then he had constant visits from father, mother, sisters and friends, had long conversations with them, and could never understand how his nephew had never seen or heard them. And so he gradually wore away to the Land of the Leal, reaching it quietly in his sleep in the early morning of Dec. 13th, 1927—and so another "Saint of God" went to his rest.

H.M.L.

December 7th, 1928.

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BOOKS.

THE AMERICAN ENGINEERS IN FRANCE.

By WILLIAM BARCLAY PARSONS, D.S.O., Colonel of the Eleventh U.S. Engineers. (D. Appleton & Co., New York and London. 1920.)

It is much to be regretted that the existence of this useful book, published in 1920, was almost unknown in this country until its author presented a copy to the Imperial War Museum in 1928. It should find a place in every military library, because it contains information in a very readable form which will interest not only the military engineer but also the staff officer who has to study the problems of organization and equipment of an army in the field.

The author deals with almost every kind of work with which Engineers are concerned in modern warfare. He did not intend the book to be a history, or to give a detailed account of the work done by the American Engineers in France. He wrote primarily in order to give those who did not go overseas a picture of what is meant by engineering in a modern war. "Military engineering"—he writes—"consists in doing things "in the simplest and quickest way, where permanency in character and "accuracy in execution yield to the imperious demands for results that "are immediately available regardless of all other considerations." To those who did not have the opportunity of seeing the American Army at war, the book will be of special interest, and will give them some idea of the immense achievements of the American Engineers behind the line, which enabled the American Army to take the share it did in the autumn campaign of 1918.

The engineering subjects with which Colonel Parsons deals include:—The new military engineer—military and civil engineering; Franco-British engineering problem; America's problem; Engineer organization; Organization of engineer troops in the field; Engineer organization and engineer work in the U.S.A.; Base ports, and their development and control; French railways; American railway operations in France; Storage yards and other railway construction; Forestry; Water supply; Tunnelling; Gas; Camouflage; Maps; Flash and sound ranging; Searchlights; American artillery, and railway guns; Light railways; Roads; Trenches and trench warfare.

Under each of these headings the author not only describes generally what the Americans did, but he prefaces each account with a brief description of the methods and organization adopted by the British and French armies as a result of the experience of nearly three years of war, and compares them with the system adopted by the Americans.

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The Americans were fortunate in being able to reap the fruit of the experience gained in 1914–1917 by the two great Allied armies, and they were quick to grasp the good points in each system and adopt what was most suitable to American practice and character, once they were convinced that their own system was unsuitable or capable of improvement. They had just been at war themselves, for nearly three years, on the Mexican border. Before joining the Allies they had already realized that what was sufficient for Mexico would be wholly inadequate in Europe, and they came to France with open minds. A great responsibility, therefore, fell on the shoulders of men of the type of the author of this book, who accompanied the first troops—Engineers—of the American Army to land in France. They were big men with big ideas, and lost no time in putting those ideas into practice. The American Army owed much to the breadth of view of its pioneers in the "invasion of France."

Not the least interesting chapters of the book are the two entitled: "The American 'R.E.s'" and "Relations with the French." In the former, as the title indicates, Colonel Parsons writes in the warmest terms of the very friendly relations that existed between the Engineer battalions, which were the first American troops to arrive in France, and the units of the Corps of Royal Engineers alongside of whom they served. He was deeply impressed by the sterling qualities of the British soldier, and lays particular stress on the relations between the British officers and their men. "They (the Americans) saw"—he writes—"that the "British officer, in spite of an assumed indifference, cared for his men as "the officers of no other army did; they saw in him one brave to reck- "lessness, they knew that he never ordered his men to do what he would "not do himself. These qualities naturally won the full respect and "implicit confidence of the men, and established between officers and "men a mutual respect that won the admiration of the observer. . . It "is a pity that more American units could not have served with the "British forces, but it is hoped that enough did so to lay the foundations "of a fuller understanding and a better feeling among all branches of "the English-speaking race."

Colonel Parsons was a shrewd observer. In his appreciation of his French comrades-in-arms, he admits that the Americans were totally unprepared for the calm self-control not only of the French soldier, but also of the nation as a whole, and pays tribute to the conduct of the women of France in the midst of danger and the destruction of their homes and country.

Other chapters deal with engineer work in conjunction with the British in the Cambrai offensive and defensive: and the St. Mihiel offensive. The concluding one is devoted to statistics—useful and instructive to us, and indicative of the methodical thoroughness with which Americans are accustomed to compile statistical data relating to their enterprises in war and peace, a trait in their character traceable to the strong Teutonic element settled in the Middle West, which during the last fifty years has had such an influence on the development of the modern American citizen.

H.B.-W.

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THE LAKE PLATEAU BASIN OF THE NILE.

By H. E. HURST.

Parts I and II. CAIRO MINISTRY OF PUBLIC WORKS.

(Price 6s. 6d.)

These two Reports are the result of two missions by Dr. Hurst; the first in 1924, the second in 1926.

The plan shows the ground covered by the two journeys. 1,050 miles were done on foot or bicycle in the first journey, and 2,260 miles in the second.

Naturally, much geographical information was collected and detailed descriptions of rivers and geographical features, of natives, of animals and insects fill several pages of the Report; and very interesting photographs give an excellent idea of the type of country.

The object of the journeys was to acquire further information on the physiography, hydrology and climatology of the Upper Nile Basin, and so to co-ordinate existing knowledge on that area.

Nile Control, published in 1920, outlines various works, suggested several years before, to be carried out on the Blue and Upper White Niles, essential to increase the irrigation of Egypt: and so provide cultivated land for her increasing population.

The real problem is how best to develop the enormous resources of the Blue and White Nile waters and to irrigate new areas of land in Egypt and the Sudan or to improve the irrigation of land already cultivated.

Both Niles are equally important to Egypt. The Blue Nile provides the Nile flood: the rains of Uganda and Tanganyika contribute largely to the low stage supply of Egypt.

This low stage supply is quite insufficient and schemes to increase it make it essential to study the climate and physical conditions of the Lake Plateau Basin. To develop the cultivable area of the Nile Basin to its fullest extent, water must be stored from the flood to increase the supply of the low stage, as is done by the Assuan Dam, and further, water must be stored in years of good supply to cover deficiency in bad years.

The latter is only possible in the Great Lakes, where a rise of level does not increase greatly the water losses, and where a small change of level implies a large volume of water impounded or released.

Also to make a programme for summer irrigation, one must forecast the low stage supply, and hence one must study the physical facts whence that supply comes. The Reports contain data showing the mean annual rainfall gauge readings at various places, and discharges of the various lakes and rivers flowing into them.

Briefly, the Rift Valley, or Albert Lake system has an area of 53,000 sq. kilom., Lake Albert's share being 5,300 sq. kilom. The area of land basin draining to Lake Victoria is 193,000 sq. kilom.: the area of Lake Victoria is 69,000 sq. kilom.; while the total area of Egypt that can be cultivated is only 30,000 sq. kilom.

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The quantity of water received by the Lake Victoria is about 100 milliard cubic metres per annum, or 40 times the amount stored by the Assuan Dam.

Evaporation on the Lakes probably equals the rainfall on those Lakes: but over the swamp areas possibly evaporation and transpiration from the vegetation exceed the rainfall. The run-off of water from the various basins can only be very roughly determined.

Discharges of the various rivers and lakes have been roughly determined but much requires to be done to improve existing knowledge, and this must be spread over a series of years.

The following is a summary of the hydrological information:

Mean annual rainfall in Lake Victoria Basin ...	1,190 mm.
,, ,, ,, ,, Lake Kioga Basin ...	1,300 mm.
,, ,, ,, ,, Lake Albert Basin ...	1,380 mm.
Annual evaporation from Lake Victoria ...	1,300 mm.
Mean daily evaporation from Lake Victoria ...	3·6 mm.
Mean discharge out of Lake Victoria over Ripon Falls	640 m.³ per sec.
,, ,, out of Victoria Nile entering Lake Albert	670 m.³ per sec.
,, ,, of Albert Nile out of Lake Albert	840 m.³ per sec.

The changes of level of Lakes Victoria and Albert agree fairly well with the estimated figures of the factors which affect those changes: *i.e.*, rainfall, evaporation, run off and outflow.

Thus, in the case of Lake Victoria:

(1)	Rainfall on the Lake per annum	1·260 metres.
(2)	Add run-off from the Lake Basin distributed on basis of rain of S. part of basin, allowing 15 days' lag ...	·330 metres.
(3)	Discharge over Ripon Falls 640 m.³ per sec. gives 290 mm. if spread over the Lake	·290 metres.
(4)	Evaporation	1·310 metres.

Thus, on Lake Victoria, evaporation and direct rainfall are nearly four times as important as run-off from the remainder of the basin and outflow.

The inflow from Lake Victoria into Lake Albert is about twice the run-off from the catchment area.

The outflow by the Albert Nile is 25 per cent. greater than the inflow from the Victoria Nile.

To give quantities for Lake Albert:

	Million metres.
Run-off, including Victoria Nile inflow ...	4,500
Rain on Lake Albert (1,380 mm.)	2,400
Evaporation on Lake Albert	2,600
Outflow to White Nile	4,300

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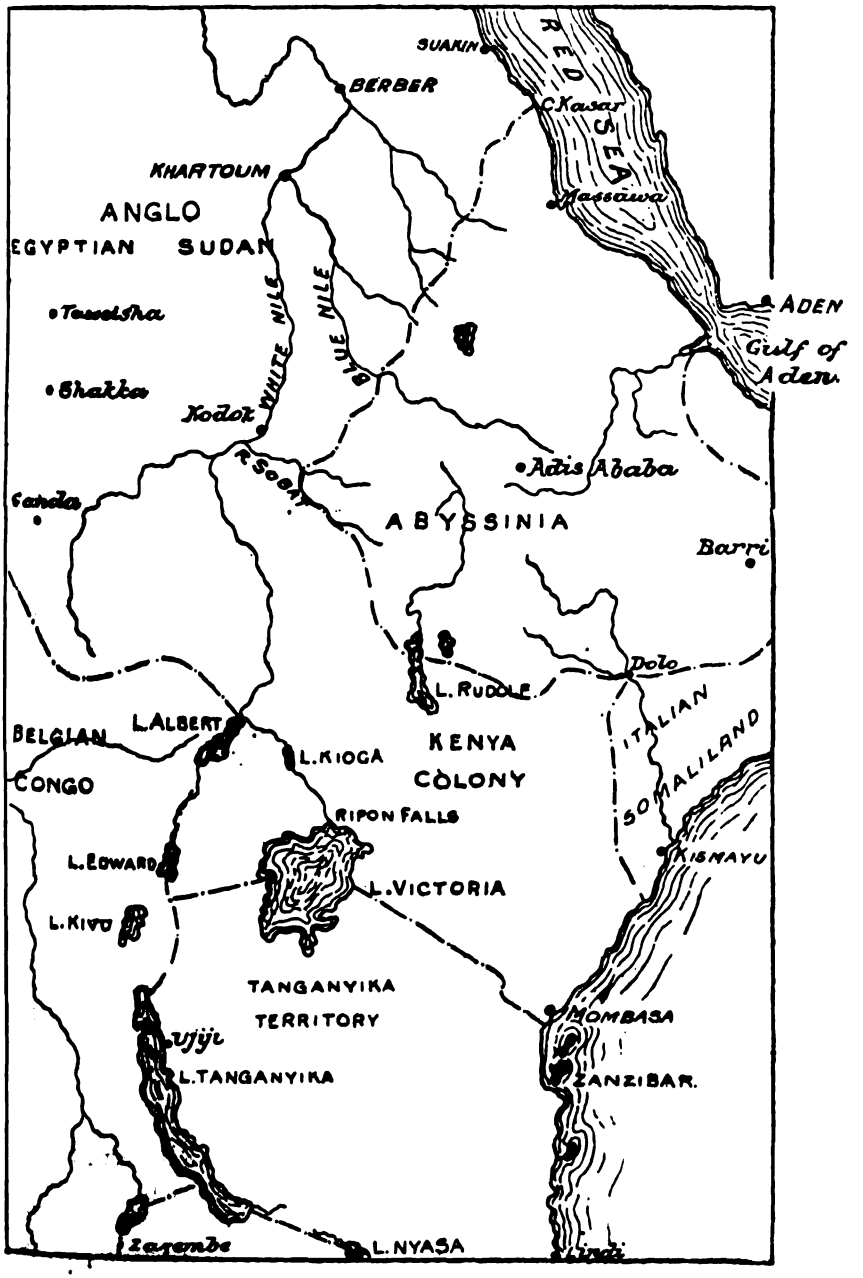
THE LAKE PLATEAU BASIN OF THE NILE.



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These figures show the importance of evaporation. The Rift Basin has mostly mountain streams and few swamp areas. The Victoria system includes large areas of swamps and many of its streams are swamps. Obviously, these lakes and swamps are responsible for huge losses of water by evaporation. They require much further investigation and survey. Surely there is wide scope here for air survey at regular intervals: to show increase or decrease of vegetation and of water levels.

The growth of papyrus is perhaps the most important hydrological factor both for navigation and for irrigation. Hence early study of the habits of swamp vegetation is important.

Topography, survey, and levels can be taken once for all and quickly. River discharges, varying water levels, and rainfall figures require years for the collection of reliable data: hence the following are advised:

(1) The measurement of quantities of water passing all the principal points.

(2) The meteorology of Central Africa and allied regions.

(3) A study of the salinity of the lakes.

(4) Collection of all hydrological information for all remote parts of the Nile Basin.

During the time of shortage of water in Egypt, about 50 per cent. of the total supply of the Nile comes from the Equatorial Lakes.

By regulating these Lakes, the supply of good years can be made to augment the supply of bad years. Much information spread over a series of years has yet to be collected to enable full value to be made of these resources.

The Reports, of course, give much detail of these facts and figures, showing how they are derived; and it is not so dry as the above would indicate.

The study of the figures themselves is not uninteresting and to think out what use can be made of them by making dams, raising lake levels, or cutting sudd regions or improving river gradients is very fascinating.

The photographs add greatly to the interest of the book and the accounts of the country passed through are of value to future travellers; while Professor Schwarz's theory that the waters of the Lake Victoria will some day flow into Lake Tanganyika or the Congo will not worry any generation for thousands of years to come, if ever, according to Dr. Hurst.

In addition to the geographical interest given in these Reports, there are appendices on salinity of the waters of the lakes, methods of discharge, measurement, and a note on the Mbuga soils of the Lake Plateau region and the alluvia of the Kagera River.

S.F.N.

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A DISTINGUISHED CHIEF ENGINEER.—THE LIFE OF JOHN MONTRESOR.

By J. C. WEBSTER, F.R.S.C. (Transactions of the Royal Society of Canada—a Presidential Address. Ottawa, 1928.)

The subject of this sketch was born of Huguenot extraction in Gibraltar on April 6th, 1736. He served as an assistant engineer under his father, James Gabriel Montrésor, who was himself a Colonel of Engineers, for four years, and in December, 1754, went to America with General Braddock as an engineer, holding the rank of ensign. In the battle of July 9th, 1735, in which Braddock was defeated and killed, John Montrésor, who had just been made a lieutenant in the 48th Regiment, was wounded. During 1756–57, he was employed as an engineer at Forts Edward and William Henry. In 1758, he served as an engineer at the siege of Louisburg, acting under the Engineer Director, Colonel Bastide, and the Sub-Director, Major McKellar. Later, he served throughout the siege of Quebec. After continuing to serve in Canada to the end of the Seven Years' War, and then in the wars against the Indians, he went home in 1767, and was given a warrant as Chief Barrack Master of the Ordnance for North America. He immediately returned to America, and was employed in various parts of the Colonies. When the Revolution broke out he was in Boston, and was with Lord Percy during the Battle of Lexington. He became the principal engineer in the army, and served on till 1778, when his health broke down and he returned to England. Soon after he was made a colonel and retired, taking up his residence at Belmont, in Kent. He died in his London house in Portland Place on June 26th, 1799.

"Of the many distinguished British officers who served in America "during the second half of the eighteenth century, it is doubtful if any "had a more varied or more interesting career than John Montrésor. "He was a man of strong character and great determination, performing "his duties with energy and enthusiasm. He had a keen and critical "mind, and his abilities were manifested in varied directions. As a "military engineer he stood in the highest rank. As a surveyor he had a "most extensive experience. . . . One of the very best portraits of "James Wolfe was made by him at Quebec on September 1st, 1759, "and was probably the last made of the General in life; it was afterwards "engraved in London. His many journals and reports indicate that he "had exceptional powers of observation, and the gift of terse expression. "His journals of the sieges of Louisburg and Quebec are interesting ". . . and those dealing with the operations during Pontiac's War and "during the Revolutionary War are of the greatest value. He could be "severely critical and unsparing in his words of detestation for those "whom he disliked or despised. He hated General James Murray, "under whom he served at Quebec after the capture, and refers to him "as a 'tyrant' and a 'madman.' On Clinton he poured forth his scorn "in a page of Spanish and French. He expressed fierce resentment at "the rewards and promotion of other officers, when he felt that his own "services had not been sufficiently recognized.

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" He backs up his pretensions to preferment by referring to the military " services of his ancestors, to the commissions which he purchased for " his sons in their army careers, to the loss of two brothers in the service, " to the death of his father, ' who,' he says, ' broke his heart in his " Retreat, for being neglected and deceived by His Majesty's Deceitful " Servants.' Finally he refers to his wife and her family as follows: " ' My wife lost her father and a brother in its cause, and her numerous " relations are reduced from Opulence to Poverty for their Loyalty and " attachment to the Crown of Great Britain.'

" In the later years of his life he recorded his criticisms of the military " operations of the British in the Revolutionary War, and gives in his " frankest manner his reasons for their ill-success. These may be com- " mended to all students of the period, making full allowance for his " personal prejudices and antipathies, impartial readers must admit the " reasonableness of many of his views, whether they refer to adminis- " trative errors in England or to the actual conduct of affairs in " America."

One of his greatest grievances related to the failure to grant proper rank to Engineers. " Though he had served 28 years in the Army, of " which 24 had been spent in America, and though he acted as Chief " Engineer, he was only a Captain when he retired in 1778. Indeed, at " this time Engineers were in a peculiar position. They were scarcely " considered as belonging to the military caste. They did not gain pro- " motion by seniority, nor were they given rank in the regular manner. " Usually they were designated as ' Mr.' When rank was granted by " the King, it was considered as an honorary title.

" Among Montrésor's papers is an admirable presentation of the " anomalous situation relating to Engineers in the Army, with a strong " plea for reform, calling attention to their much higher status as regards " rank in various European countries. His closing paragraph reads as " follows :—' It's rather extraordinary that in a country where the Arts " and Sciences are so much encouraged that a scientific body, and of " so important a nature that the very Defence of the Realm depends " upon, should be so totally neglected.' It was many years before the " Engineer Corps was established on its present basis."

H.B.-W.

OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914-18.

Volume IX.—The Royal Australian Navy. (Angus & Robertson, 89, Castlereagh Street, Sydney. 21s.)

This volume of the series contains 649 pages, with 90 photographic illustrations and 28 maps, and has been placed in the R.E. Corps Library at the Horse Guards, together with the other volumes of this series already received.

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A SHORT ACCOUNT OF CANTEENS IN THE BRITISH ARMY.

By The Hon. Sir John Fortescue. (Cambridge University Press. 3s. 6d. net.)

The historian of the British Army has again placed those who are interested in his subject in his debt. Many a young officer, and many an old one for that matter, forgetful of the curse pronounced against the Serpent after his adventure with Eve, has said he would do this or that till brought up short by the pronouncement of "Q," who simply says "you can't." This book of seventy-nine pages does not deal with the more spectacular, and, to most, the more interesting side of the Art of War, but with the Organization which in peace and war supplements the official ration, and helps to provide that degree of comfort and sustenance for the human machine without which all the best-laid plans of "G" are of no avail. From the earliest days of organized warfare, armies in the field have been accompanied by private adventurers selling foodstuffs to the troops. So necessary to the welfare of the armies were these traders that they were soon officially recognized and regulated. In the British Army these gentry were termed sutlers, and during the fighting in Flanders under Marlborough, the Commissary supplied bread only, and for all other supplies the troops were dependent on the sutlers. It is rather startling to be made to realize that in Britain, apart from a few fortresses like the Tower of London, there were no barracks for the soldiers to live in before the very end of the eighteenth century. The men were billeted in ale-houses, "whose landlords were required under the Mutiny Act to provide them at a fixed tariff per man with food, fire, and candle." It also helps one to get things in their right perspective to remember that, in a gradually lessening degree till the old system finally disappeared in 1871, "regiments were the property of their colonels, and troops and companies of their captains, all of whom enjoyed considerable independence. The Army, in fact, was not an army at all, but a collection of regiments. The welfare of the men depended entirely upon the regimental officers, and we shall presently see that all the improvements in their condition have been originated by regimental officers."

During the eighteenth century, troops stationed abroad were fed practically as they would have been at sea, on salt provisions, and for the rest they lived as best they could, or died. For wars on the Continent, contractors were always forthcoming to act as sutlers up to the time of the war in Spain. In India, too, there was no difficulty, but in the American continent it is not known really what arrangements it was possible to make during a campaign. During the war in Spain and Portugal, no contractors were forthcoming, and the Commissariat had to do the whole of the contractors' work for themselves. Wellington had to build up a completely new system to meet this need, and it took three years for the Treasury to grasp the fact that they were up against new conditions. From the time of the Battle of Waterloo till the Crimea, three out of every four line battalions were abroad and generally fighting. During this time, as a result of the building of regular barracks at home, it had been decided, as the less of two evils, to allow spirits to be sold in a

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canteen within the barrack area: other articles were added later, but the quality of all that was sold was poor and the price high. The State, however, made some £53,000 a year from the contractors (really from the troops) as rent for the canteens. The system was gradually improved upon by the regimental officers, who provided the means for the privates to obtain cheap suppers, started libraries, or even formed theatrical companies from among the men. From 1836 onwards, "the State began from very shame to learn from the officers, and in 1847 it was openly proposed in the House of Commons that the existing regimental canteens should be replaced by coffee-rooms, and that the profit arising therefrom should be devoted to the upkeep of reading-rooms and other institutions for the soldier's benefit." The Crimean War was followed by many administrative and other changes in the Army, and by the new canteen regulations of 1863 "the canteen was established as a regimental affair. The commanding officer selected a canteen committee, consisting of a president and two subordinates, and purchased his goods for the canteen in the open market from any tradesman or tradesmen selected by the Committee." The abolition of long service about 1870 meant that the character of the Army was radically changed. The long-service man had inherited traditions of hard drinking, which disappeared more and more with the change in the character of the recruit.

In 1894, Major H. J. Crauford, of the Grenadier Guards, Capt. Lionel Fortescue, of the 17th Lancers, and Surgeon-Captain H. M. Ramsay, medical officer attached to the Scots Guards, founded a co-operative society, known as the Canteen and Mess Co-operative Society, the object of which was to obtain for regimental canteens dealing with them supplies of a good quality at a reasonable figure. The capital was £400, and the interest thereon was limited to five per cent. In spite of "fierce competition from the firms which had enjoyed the monopoly of canteen business, its trade steadily increased. In 1896, the Society moved to much larger premises in Regency Street, Westminster; and very soon Captain Fortescue, enlarging upon Major Crauford's original idea, conceived of a plan by which he hoped to place the Society upon a much stronger footing. This was that the customer-regiments should gradually buy out the individual shareholders, making the Society their own; that eventually the whole Army should be included, and that the Society should be the whole Army's Co-operative Society, conducting its own business for its own officers and men, and distributing the profits, both wholesale and retail, among them without any official interference whatever. The scheme was derided by most officers as an idle dream, but Captain Fortescue never lost faith in it." We have no space to trace out in this notice how this dream was eventually realized; it must suffice to give two more quotations from our author. Speaking of the founding of the Navy, Army and Air Force Institute on the 1st of January, 1921, he says, "Thus at last the co-operative principle was accepted as that which should govern the canteen service. In 1863, canteens had been made the subject of contract, and for 50 years that system had been accumulating the steady pile of damnation which reached its climax in the canteen scandal of 1914. The co-operative principle had been initiated (as may be once more repeated) in 1894. Lord Gray's Committee had recom-

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mended its adoption in 1902, but in vain. Four more committees in 1914, 1916, 1920 and 1921 upheld it; and it is interesting to note how many committees are necessary to break down a system which has been abundantly proved to be vicious. But in truth it was not the committees, but the astounding work of the E.F.C., itself the offspring of the Canteen and Mess Co-operative Society, which fairly compelled the formation of a similar permanent organization for the fighting services, not only in time of peace, but, if fate should ordain it, also in time of war."

And again: "To the present writer, who has followed the life of the British soldier closely through the centuries, the establishment of the N.A.A.F.I. presents itself on the whole as the greatest benefit that has ever been conferred upon the Army. As an ordinary householder he greatly envies the officer, soldier and their families, who are privileged to take advantage of it. Had they any conception of what their predecessors had to put up with, they would cherish it to the uttermost. But man is a suspicious animal, and it is probable that the N.A.A.F.I. is not so well appreciated as it might be. Moreover, there is always a lingering apprehension in the soldier's mind—too well justified by past history—that his employer, the State, is always trying to get the better of him. Hence there remains the tendency, in case of any little failure or disappointment (for the institution which never was guilty of failure has never yet existed in this world), to blame some vague person or persons who are supposed to be at their old nefarious work. . . . They must realize that the N.A.A.F.I. is not a force imposed upon them by external authority. It is their own Institute, built up by themselves for their own benefit."

P.H.K.

"POLITICAL MEMOIRS, 1914-1917."

Pages from my Diary. By PRINCE NICHOLAS OF GREECE. (Hutchinson & Co., 1928. Price 24s.)

It was generally believed during the War, and after, that the late King Constantine—influenced by his German Consort—was mainly responsible for the refusal of Greece to join the Allies.

This volume has been written by a brother of the King to show not only that there was no real ground for this belief, but, moreover, that the King was cruelly maligned and wilfully misunderstood by M. Venizelos. This well-known statesman was the leader of the Liberal party in Greece, and, up to March, 1915, Prime Minister. Prince Nicholas endeavours to show how it came about that M. Venizelos and the newspapers he inspired were responsible for misleading the world as to the true facts.

King Constantine was a soldier in more than name. He had won his spurs in two victorious campaigns, and if Greece had joined the Allies in 1915, he would have led her armies as Commander-in-Chief. He was

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extremely popular with the people: he understood them, and they trusted him. He realized that the Greeks were not only tired of war, but were totally unprepared for another struggle; and it was for these reasons that he stood firm from the first for Greece's neutrality in the general conflagration in Europe.

He and his General Staff were always suspicious of their former adversary, Bulgaria, and were determined to safeguard the conquests they had made, at all costs. It was because they lived in fear of a war of *révanche* that a defensive alliance had been entered into by Greece with Serbia, under the terms of which each was bound to go to the assistance of the other if attacked by their former enemies.

Much has been written and said about the failure of Greece to go to the assistance of Serbia when the latter was threatened by the combined forces of the Central Powers. Prince Nicholas shows that M. Venizelos must share with the King the responsibility for the decision. They held that Serbia, attacked by Austria and Germany, as well as by Bulgaria, could not possibly be in a position to fulfil her promise to send the 150,000 men that Greece had stipulated, to the aid of Greece if the latter were attacked, and that for self-preservation Greece must first safeguard herself against direct attack by Bulgaria, backed as she would be by Germans, Austrians, and probably also Turks. King Constantine and M. Venizelos were both determined that Greece should not be deprived of the territory she had won. M. Venizelos, perhaps, held a longer view. He believed that with Entente assistance Greece would be able not only to hold on to what she had won, but in the event of an Entente victory, might gain territory elsewhere. Like all good Greeks, he, no doubt, had dreams of re-establishing the Byzantine Empire. Unfortunately for Greece, the Allies were determined that this should never be, and they had already clinched the matter by promising Constantinople to Russia.

When the Allies began to realize the potentialities of the coastline of Greece for German and Austrian submarine bases, they redoubled their efforts to persuade Bulgaria to join them. They were apparently convinced that the fears of Bulgarian aggression were groundless, and they refused to accept the Greek point of view. Moreover, not content with thwarting the aspirations of Greece, they grievously injured her *amour propre* by offering to restore to Bulgaria part of the territory which she had lost to Greece, as a bribe to King Ferdinand to join them. This the Greek nation could not stomach, and the King and M. Venizelos correctly interpreted the sentiments of the whole nation in protesting against this insult. The King became only more determined that nothing but Bulgarian aggression would induce him to abandon neutrality. M. Venizelos—an optimist always, and a believer in the ultimate success of the Allies—cherished the idea that if Greece could not get help from Serbia she might get it from the Allies. He persuaded the King to agree with him under certain stipulations, one of which was that Allied assistance must be in the form of "Metropolitan Troops, not Colonials." Presumably the King would not be content with anything but regular white troops, whether French or British: he had seen what had happened in Gallipoli, with raw, half-trained levies.

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M. Venizelos, not content with the half-hearted acquiescence of the King, then took upon himself to invite the Allies to Salonika. This fact, Prince Nicholas states, only became known to the world after the War. He goes on to discuss the extraordinary situation after the arrival of the Allied contingents. Foreign troops in a neutral country, with the representatives of the enemies of the Allies still installed at Athens! From this moment, M. Venizelos was definitely, if not openly, at loggerheads with the King; and the story of intrigues, to which such a situation was bound to give rise, is a sorry one. Prince Nicholas has no use for the diplomatic representatives of the Allies at Athens. He charges them, and particularly their creation—the Allied Intelligence Corps—with concocting all kinds of false stories of Greek delinquencies which were widely circulated by the Venizelist Press at their, and M. Venizelos', instance. He describes the landing of the French Marines at the Piraeus, and attributes the conception of that intervention to M. Venizelos, who must, he says, have been well aware of the inevitable consequences. M. Venizelos was obsessed, he says, by the desire to force the nation into the War at any price, even if it involved the removal of the reigning sovereign, if not the overthrow of the dynasty. As to the subsequent action of the Allied diplomats, he is very outspoken, and although it is evident that he considers that all were involved, he attributes most of the trouble to the French Government, and to the politicians, military, naval and civil, who were its representatives in Greece.

In a chapter on General Sarrail at Salonika, he describes the French General as—"though a soldier, he was a militant republican and "politician as well: in the course of his command in the Near East "these 'credentials' were often combined." He regards him as having been the prime cause of the Greek refusal to join the Allies, when shortly after his arrival he ordered the demolition of the railway bridge at Demvir Hissar on the Struma river, thereby cutting off the Greek forces in Eastern Macedonia from their base at Salonika, and completely upsetting the Greek strategic concentration and cutting the Greek forces in two—in other words, completely paralysing them. Prince Nicholas also describes the circumstances that led up to the inexplicable surrender of two Greek divisions at Cavalla to the Germans, and their removal as prisoners of war to Germany. He records that the King and the Government were entirely unaware of what was happening there, and only heard of the surrender after the first Greek detachment had arrived in Germany. After describing the revolution engineered by M. Venizelos, the book ends with the exile of King Constantine and the accession of his younger brother. Not a single mention occurs in the book of the British Commander-in-Chief, or of the troops under his command.

The book should be read, for it gives us a very different view of what happened in Greece to what we are accustomed. The reader who has also read the author's companion volume, *My Fifty Years*, in which the Asia Minor campaign is described, will gain a very good idea of the Salonika "venture," from the Greek point of view. But it will not increase his admiration for Allied diplomacy in the Great War.

H. B.-W.

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RAILWAYS.

By W. V. WOOD, Controller, and SIR JOSIAH STAMP, President, L.M. & S. Railway.

(Published by Thornton Butterworth. Price 2s.)

This perhaps is the first book to be published by any English railway dealing with its business in a manner not suitable for the juvenile reader. But it is difficult to place its exact intentions. In the first chapter, we read: "The first fruits of division of labour were functional, the second into which we now enter are spatial or localized." Whatever this means, it is rather unsuitable for either the general public or the railway student. In another chapter, we read: "The admission of steam into a cylinder forces a piston to the other end, and this force . . . causes the wheels to revolve." These remarks seem more suited to the nursery rather than to form a basis for the "new thinking" which the book is intended to promote.

A few lines further on, we are told that the power of a locomotive depends on various details of its design. Details of design are now more or less stereotyped, or should be so, and for the informed reader, the important feature in any locomotive is the amount of coal it can burn in, say, half an hour.

A chapter is devoted to the elementary history of transport.

A chapter on statistics devotes more attention to their abuse than their use. The fact is statistics compiled all over the world have already brought about the solution of the major problems of railway working, and it is rather late in the day for English railways to begin compiling them. It would be sufficient to make use of the experience gained elsewhere, and apply the general principles of railway economics which this little book briefly and accurately describes.

The advantage of high train load and large wagons is correctly described, but one looks in vain for a reasonable explanation for the failure of English railways to increase wagon load and train load. We are told that dealers in household coal like to get supplies in five-ton daily lots. An inadequate excuse for an apparent loss of millions in working expenditure. We read that another reason is to be found in the smallness of the average goods consignment. This again is unconvincing as 80 per cent. of the traffic is in minerals and metals, which are consigned in full wagon loads.

The loss on working the freight traffic can be readily estimated. The average wagon load is 3 tons, and each wagon weighs 6 tons empty. The small load is due to private wagon empty haulage, and small capacity for loading light goods. In well-designed stock the average load may be 10 tons for 8 tons weight of wagon for a similar class of traffic. By simple proportion, we find that for every 100 tons of freight carried, 80 tons of dead weight is good practice, but English railways carry 200 tons of dead weight. The balance, 120 tons, is being dragged about the railways wearing out the rails, using up labour, and burning coal.

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Probably £10,000,000 is lost on this in working expenses. The shunting mileage is 80 per cent. of the train mileage, an appalling figure, and leaving room for an economy of millions.

The book gives a fact not generally known, that the rails in common use are 95 lb. per yard. Such rails are suitable for 20-ton axle load on the wagons and 25 tons in the engines. The majority of the wagons have only 8-ton axle loads. This means that much of the capital outlay on the rails is wasted.

The real reason why English railways do not increase their wagon and train load is that until they increase the size of the loading gauge it is impossible to increase the size of the engines. They are unable to face the capital outlay to do this. It would be impossible to raise the money, and they have no reserves. We read that coal consumption is carefully watched, each driver and stoker's record is watched. The drivers and stokers are the best in the world, and watching them seems superfluous so long as every goods train contains 180 tons of unnecessary dead weight, out of a total weight of 400 tons. Actually, it must be worse than this. A reduction of dead load would reduce the number of trains, engines and brake vans in use, and the total waste load is probably 240 tons for every 120 tons of paying load. This is the unnecessary dead load, excluding the unavoidable dead weight of trucks and engines amounting to 175 tons.

On page 89, it is stated: "In their general design, wagons have altered little in the last 100 years." Comment would be superfluous.

Enlargement of the loading gauge will equally affect the passenger traffic, and make it possible to cope with London suburban traffic, and gain the full value from electrification.

An interesting chapter on Government control leaves the impression that Government acquisition of the railways would come as a relief to a hard-pressed railway administration.

The railways have been so much interfered with by the Government, that they might well demand that the Government should take control. Certainly the shareholders have every reason for demanding such action, their interests having often been lost sight of.

Private ownership in industry combined with individual effort may always be preferred to State ownership, but in large corporations individual control is lost, and the history of our railways, which were amalgamations of a number of small lines made 60 years ago, shows only too clearly that amalgamation, although it has obvious advantages, has also many drawbacks.

The remedy for regaining effective individual control of large amalgamations is the deferred share in the hands of a few individuals. But the stocks of our railways are too widely dispersed, and could never be collected into a holding company by private effort. The socialist dream of State control of all large corporations may, in the not distant future, be brought about by the impossibility of otherwise controlling them. Certainly our railways are ripe for it. State acquisition would enable the State to control all the railways by means of a small board of two or three railwaymen. Their first act would be to repeal the existing railway laws, and enact a simple code in their place.

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They could then find the money, and proceed to modernize the railways. Many of the unemployed may be absorbed in this work for five years. A few small companies would be formed to work the traffic on lease.

On page 226, it is stated that "the low return in the industry is due to the fact that a greater part of the capital was issued when money was cheap—74 per cent. receives only about 4 per cent." This would convey to an uninformed reader the idea that the low net earnings of our railways are due to the cheap credit which they alone enjoy. A decidedly new point of view.

There is much said about the hours of labour, and it must be admitted that railway labour has done very well out of the War. The book makes the statement that the rise in the cost of labour is 150 per cent. or, allowing for rise in prices, 50 per cent. on pre-War expenditure. One can only admire the railwaymen for getting the best of it, and ask the administration why they have been bested.

That the technical labour know their job, no one can doubt. One may kill a salmon on the Usk at 4 p.m., and have it delivered in a remote village, 100 miles away, through three junctions, by 10 a.m. the following day, for the sum of 2s. 6d. No railway in the world can beat this, but what one would like to know is why, with this wonderful labour staff, and with 70 per cent. of their capital in 4 per cent. irredeemable debentures, and high rates ruling, the L.M. & S. stock has fallen from £137 to £50 per cent. since 1910, while at the same time railways with fewer advantages all over the world are more prosperous than ever before? Motor competition has very little to do with it. Motors make more new railway traffic than they take away.

The irredeemable debenture is not the least of the mistakes of the early railway legislation. If the railways had been obliged to renew their debentures every few years, it would have been much better for their health.

L. E. HOPKINS, Lt.-Col.

LUFTFLOTTEN (AIR-FLEETS).

Published by the *M. und T. Mitteilungen*, Stubenring 1, Vienna I. 380 pages, 53 illustrations. Price, 5s. paper covers, 6s. half-linen.

This, the latest production of the *M. und T. Mitteilungen*, consists of a collection of thirty-three articles written by experts, all dealing with some aspect of aerial warfare. *The Air-fleet Politics of the Great Powers* is followed by *Organizations and Strengths of the Armed Air-fleets of the World*, in which a prominent German writer on aerial matters accords to the British air forces a political significance greater than, and a fighting value nearly equal to, that of France. The editor of the *Aeroplane* discusses *The Military Significance of Civil Aviation*, and leads us to the following conclusions: as regards personnel, practically negligible; as regards equipment, practically negligible; as regards ground organization, vital.

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Aerial Warfare Questions is based upon an article by Col. J. F. C. Fuller. *What are the present performances of aircraft?* is then answered, as also another question, this time frankly controversial, *Fighter or Cruiser?* in which we are given the arguments of both parties. After *Air-fighting Formations* comes *Teachings of Up-to-date Manœuvres*, in which a Hungarian officer denies the contention by the English Press that the defencelessness of London was clearly shown by the manœuvres of July, 1927. The next article, *The Disarmament of Air-fleets*, by Col. Streccius, of the German War Office, and member of the permanent consultative Commission for Aerial questions of the League of Nations, may occasion some surprise in its present company, as a Daniel among the lions. Granting that air-disarmament is to be aimed at, the author rejects as impossible the abolition of all military aviation, and as insufficient, failing good-will, the limitation of numbers or horse-power. If the nations will do nothing of themselves, and it is left to the League of Nations to take the first step, then the demand must be ABOLISH ALL BOMBING!

After this we get back to business with *The Airship as a Weapon in Land and Sea Warfare, Past and Future.* Every weapon has its day until a more effective one arrives. The aeroplane took the airship's place in land warfare, because it can fulfil the same tasks better and with less danger to itself. "Never again will an airship take part in land warfare." It is quite another story when we turn to the sea. There the airship's important duties remain, distant reconnaissance, escort-duty, patrolling, mine and submarine hunting. The activity of Great Britain, the U.S.A. and Italy shows them to be alive to this fact: only France and Japan are behind. Important for further development are the two great technical advances since the War, helium-filling and the anchor-mast.

Among the photographs are the twin airship sheds on a turn-table near Cuxhaven, and the *Shenandoah* riding to the anchor-mast on board the airship mothership *Patoka.*

The Captive Balloon and the *Use of Kites for Military Purposes* are dealt with shortly. Under *Aircraft Petrol Supply in War*, estimates show that a Great Power at war in the next few years will have to import 2½ million tons of oil a year in order to get the petrol it needs for military aeroplanes alone, or more than a quarter of the tonnage of the world's oil ships. Consequently, great stores of oil must be collected in peace. Consequently, the first task in war will be to destroy the enemy's oil-reservoirs. In order to ensure the petrol to the aeroplanes it will be necessary to provide engines running on heavy oil for tanks and all motor-transport.

It is too early to take into account that installations are already working in which coal is liquified, but the development of such establishments and the perfection of their methods will have as great an effect on this question as it will generally on the world's economics.

The Influence of the Air-arm on Infantry Tactics and *The Relations Between Infantry and Aircraft* are complementary. They coincide only in considering the influence of the air as increasing. In *Gas Warfare and Smoke-formation from Aircraft*, the author considers gas pre-eminently

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the best means of waging war against human beings, and chooses the mustard-gas bomb, arranged to work 200 to 300 metres above the earth, so that the contents fall in a dust-like rain. Compared with artillery, the gas-bombing aeroplane has only one possible firing-position, viz., low down and just above the target. Opinions differ as to how much chance the aeroplane has of reaching this spot. Be that as it may, "indirect" bombardment by night, using wireless position-finding will be all in the aeroplane's favour, as will also the less noisy heavy-oil engine.

As regards the formation of smoke from the air, this is of the most urgent necessity in order to alter the state of affairs brought about in the Great War, where the continual increase of weapon-effect (the first element of tactics) made movement (the second element of tactics) almost impossible. Tactics failed in position-warfare, because the balance between weapon-effect and movement was lost.

The tank was an attempt to restore this balance, and the subsequent efforts, especially in the British army, towards complete mechanization, are a continuation of the policy started by the tank.

There are many difficulties in this way, among which may be mentioned that the tank is essentially a weapon of attack, and of attack alone, while in battle movements of attack and defence must alternate and interweave.

A new way out of the deadlock of tactics is offered by artificial smoke, which is just as promising a solution as the tank, far cheaper, and can be used always and everywhere. The best agent is the low-flying aeroplane, which, according to American trials, can produce in less than a minute a thick curtain of smoke a mile long and 500 feet high.

It is smoke produced thus, and also by the infantry by means of smoke-grenades, and by the artillery by means of smoke-shell, which will reduce the preponderance of weapon-effect in tactics by restoring movement to the battlefield, and thus raising man's value in comparison with the machine.

The next three articles are historical: *Austria's Share in the Conquest of the Air*, *Austria's Military Airships* and *The Austro-Hungarian Air-troops in the Great War*. They are followed by *Principles of the Statical Calculation of Aircraft*, *Aero-Mechanical Testing*, giving some account of towing trials and the blast method for models, and *Recent Aeroplane Types*, which describe the two latest sailing aeroplanes. The author says the ultimate object of all these sailing trials is to improve the flying qualities of the engined aeroplane.

The story of *The Helicopter* is then told, and the author includes an account of a later attempt to solve the same problems, the Autogyro, which is no helicopter, but an aeroplane with rotating wings.

Automatic Flight gives diagrams of instruments and connections by means of which Drexler claims that, after twenty years of experimenting, he has succeeded in making an aeroplane fly itself. The apparatus he has made can be fitted into any aeroplane with four screws and the inventor foresees a time when every aeroplane will be so fitted.

Sailing Flight tells what has been achieved in the Rhön, near Darmstadt, and at Rossitten among the dunes in East Prussia. The records

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for engineless flight are: longest time in the air, 14 hours; greatest height, 650 metres; greatest distance, 62 kilometres. "Sailing flight is in the best sense of the word an art, where the will of the airman, led by instinct, has to do duty for an engine." The author hopes that through generations of practice the youth of the future will possess the necessary instinct!

In dealing with *Aero-photography and Aero-photogrammetry*, the aim has been to show the degree of perfection achieved by Hugershoff-Heyde's Aerocartograph and the Zeiss-Jena Stereoplanigraph. *Aeroplane World Records* and *Aircraft Navigation Instruments* are also dealt with, and five articles on *Air Defence* bring the symposium to a close.

There follows twenty-four pages of reviews of, and notes on, the air literature of the leading countries, including a review of Gen. Niessel's *La maîtrise de l'air*, and Notes on the British Air Estimates, 1927–28, air establishments and policy. A six-page list, with notes, of the air periodicals of the world completes this air encyclopædia and leaves one full of admiration at one more example of the thoroughness with which the *M. und T. Mitteilungen* fulfils its policy of keeping Austrian officers up-to-date in those fields in which their own efforts are at a standstill, owing to restrictions imposed by the Treaty of Versailles.

F.A.I.

THE MURMANSK VENTURE.

By Maj.-Gen. Sir Charles Maynard, K.C.B., C.M.G., D.S.O.

(Hodder & Stoughton, Ltd. 1928. Price 20s.)

Why did we intervene in Russia in the spring of 1918?

It was to answer this question and endeavour to dissipate the general misconception existing on the subject in the public mind, that the author has given us this book. There were obvious political reasons why he did not put pen to paper much earlier, and there was a danger of incriminating further in the eyes of Moscow those Russians still living who, having thrown in their lot with the Allies, had declined to accept the opportunity offered them of seeking an asylum outside their own country.

General Maynard reminds us of the military and political situation at the opening of 1918, and he sums up the reasons for our intervention, as follows: "(*a*) Many more German divisions would have been withdrawn from Russia and employed against the Allies in France—possibly with decisive results. (*b*) Germany, being free to draw on the immense resources of Russia and Siberia, would have been enabled to establish her national industries once again on a prosperous footing, and to supply the needs of her civil population. The effect of our maritime blockade would thus be annulled. (*c*) North Russia ports would have been converted into enemy naval bases, submarines operating from which would have circumvented our North Sea minefields, and found our Atlantic commerce open to their attack. This, too, when the safe transport of America's armies was of all importance. (*d*) The chance would be lost of employing to any useful purpose either the

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" army of Japan or the equivalent of several divisions of Czecho-Slovak " troops of high fighting values, and full of enthusiasm for the Allied cause. " (*e*) The anti-German movement at that time beginning to gain a hold " in Russia would, if unsupported by the Allies, be quite unlikely to " achieve any tangible result."

General Maynard claims that our intervention was more than justified as a measure of sound strategy, and that the aim of the North Russia " detachment " was fulfilled with a measure of success out of all proportion to the slender means employed.

After reading the volume, it must be admitted that, in this case, if not in some others, the " eccentric " venture, entailing as it did the diversion of strength from the main theatre of operations, was in 1918 fully justified. If it did not achieve its secondary object of helping to rescue Russia from the Bolshevicks, the failure cannot be attributed to the British and Allied troops who served under British leaders in Murmansk and at Archangel.

It is interesting to learn from General Maynard that, as in the case of the Salonika " venture," British co-operation was probably secured by the fact that the British Admiralty laid great stress on the denial of submarine bases to the enemy. That this was so is evident by the veto placed on General Maynard's suggestion that the strength of his force did not allow of retaining a garrison at Petchenga, an ice-free port sixty miles N.W. of the Murmansk (Kola) inlet, and by the fact of the immediate dispatch to him of 5,000 reinforcements, to ensure the success of his advance to the shores of Lake Onega without prejudicing the safety of Petchenga.

The book has done a real service in giving us one more example of the inter-dependence of naval and military operations, and provides another argument for taking steps to ensure the very closest co-operation between the Naval and Military General Staffs in any future war in which the British Empire may be involved. It is true that there appears to have been good co-operation in this case, but there is reason to think that that result was only achieved by the personality of the occupants of the chairs at the War Office and Admiralty who were in charge of the White Sea operations. Our Imperial organization must, in future, be such that there can be no question of the interests of one branch being subordinated to those of the other. It is to be hoped that the creation of the Imperial Defence College will go far in educating those who are to be responsible for the defence of the Empire of the truth of this maxim, and the necessity of creating an organization which will effectively prevent a strong man at the head of any one branch of the Government from taking the bit in his teeth. The Admiralty was allowed far too free a hand in Gallipoli; the Foreign Office in Greece; the Minister responsible for man-power in France in the winter of 1917–18.

General Maynard does not claim to have written anything in the nature of a detailed report, nor to have produced a strategical or tactical study of the operations, but he has given us a very interesting account of a minor campaign which was in many ways unique, and was carried out by one of the most motley forces ever brought together for the

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purpose of military operations, under climatic conditions hardly ever experienced by British troops and in a political atmosphere which few at home can have realized.

It is to be regretted that the volume is not provided with a proper index: the summary of contents is hardly sufficient. A general map of Northern Russia and Scandinavia would also have helped the reader.

H.B.-W.

MEMOIRS AND ADDRESSES OF TWO DECADES.

By J. A. L. WADDELL. Edited by FRANK W. SKINNER.

(Published by the Mack Printing Company.)

This book is a collection of those of Dr. Waddell's numerous papers that had not yet been published in full in book form, and of speeches delivered to various bodies on matters relating to the engineering profession.

Dr. Waddell, in his long and busy engineering life, has seen, and taken a leading part in, the development of modern bridge engineering from its smallest beginnings, and as this is most probably the last of his works, it will be of interest to review, very briefly, his technical life before dealing with the book itself.

He was born at Port Hope, Ontario, in 1854, and received his technical education at the Rensselaer Polytechnic Institute, New York.

In 1871, he entered the service of the Canadian Pacific Railway and after seven years of varied engineering experience, he returned to the Rensselaer Institute as lecturer in Geodesy, Geometry and Mechanics. From 1882 to 1886, he occupied the chair of Civil Engineering at the Imperial University at Tokyo; after which he returned to America and practised as a Consulting Engineer.

Dr. Waddell was fortunate in that his engineering life was spent chiefly in a young and wealthy but undeveloped country, affording such great scope for major engineering works. Some idea of his vast experience may be gathered from the statement that, not counting such works as the construction of two lighthouses, harbour and dock works, railway works and other activities which would be considered a sufficiency for the average engineer, he has been responsible for the design and erection of upwards of a thousand bridges of every conceivable type, most of which may be classed as major works!

During the last forty years, covering the busiest part of Dr. Waddell's professional experience, he has found time to write six technical books (besides two written in Japan), including *De Pontibus* (an encyclopædic handbook of modern bridge construction), two volumes of *Bridge Engineering*, and *Economics of Bridge Work*. Besides those, he has written upwards of a hundred technical papers, addresses, monographs on important engineering, mathematical, constructional, ethical, and educational topics that have been published in the principal foreign languages.

To-day, Dr. Waddell is Consulting Bridge Engineer of the Port of New York Authority on the design and construction of two bridges, to

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cost some £3,300,000, that will connect Staten Island with the State of New Jersey, on which the construction is rapidly drawing to a close. He has been consulted on several other important bridge constructions now pending, including enormous spans for San Francisco Harbour, as well as the contemplated single span across the Narrows of New York Harbour, which he has estimated might be constructed at a cost of about £20,000,000 for a 5,000-foot main span with 130-foot roadway.

It will be realized that Dr. Waddell's editor, Mr. F. W. Skinner, has some excuse for his (to English ears) rather effusive style when discussing American Engineers in general and Dr. Waddell in particular; but one feels that such a record might have been left to speak for itself. Not that Mr. Skinner has any reason to fear that any slight over-accentuation of his author's undoubted merits would be likely to cause embarrassment to his subject; to read a few of the articles in Groups I to IV of the book is to realize this.

Mr. Arnold Bennett, in discussing another combination of editor and author, very aptly describes the impression created by this book. "M. Benjamin is inclined to sentimentalize the prodigiosity of Balzac's career. Balzac had not only grandeur; he was grandiose. M. Benjamin insists too much on both characteristics. He paints the lily."

The book is divided into eleven groups, the first four groups being devoted to papers and addresses on matters relating to the ethical and educational training of the engineer. This portion could well have been condensed considerably. It contains some good advice in a very great number of words. The non-technical portions of the tenth group also —"Matters Chinese"—suffer from the same defects of style. These five groups are not so much written as "orated" in windy language, sprinkled with tags of foreign tongues, and *clichés*.

The meat of the book is contained in Groups V, VI, VII, VIII and IX, which are devoted to technical matters.

The style of these technical papers is much clearer and more to the point than that of the articles in the five groups previously noticed.

Much of the matter, however, has already appeared in *Bridge Engineering* or *Economics of Bridge Work*, though in a condensed form.

The articles on the use for bridgework of alloy steels with elastic limits of 60,000 lb. and upwards, are interesting and instructive.

In 1903, Dr. Waddell was retained by the International Nickel Company of New York City, which company then controlled three-quarters of the world's total output of nickel, to make an extensive investigation into the possibilities of nickel steel for bridge-building. His experiments included all standard and many special practical tests, and occupied over three years. The result of his investigation has been the use of nickel steel for several long-span bridges, including the Manhattan Bridge, New York, the Free Bridge, St. Louis, the New Quebec Bridge, and several other important structures.

It is interesting to know that these investigations into the use of nickel steel were carried on until early in 1913, when the cost of nickel rose to an uneconomic price for large scale work, due to heavy purchases by Germany for the manufacture of War material.

Another matter which might have had some effect on the conduct of

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the War was the proposal, in 1907, to link up the Russian and United States railway systems by tunnel under the Bering Strait. A company, called the Trans Alaska-Siberian Railway Company, of which Dr. Waddell was Chief Engineer, was formed, and the preliminary work up to commencement of actual construction was carried out; but the project was abandoned because of international complications.

Articles of interest to the railway engineer are those on the creeping of rails, and the respective merits of vertical and inclined rails. The articles of most general interest, however, and those which constitute the principal value of the book, are those on the "Functions and Work of a Resident Engineer," "Bridge Economics for Foreign Lands," and "The Suitability of Bridge Types for Different Crossings."

The first of these articles gives some very useful hints on the conduct of bridging work and of any large engineering job; it would be a very valuable paper to have at hand when undertaking such works.

The other two papers mentioned properly go together; combined, they form a very comprehensive and lucid appreciation of the many factors which should be taken into account when the type of bridge best suited to any crossing or geographical situation is to be decided upon.

Without occupying too much space, more particular mention of these papers cannot be given here—except what follows on the Hooghly Bridge project, which is mentioned in the one last named—but one feels, after many weary hours of wading through so much talk that says so little, and repeats it so often, that here at last is matter which one would like to have by one always.

The Hooghly Bridge project is discussed in several places in the book, but chiefly in the paper mentioned and in a reprinted letter to the editor of *Indian Engineering*.

Dr. Waddell roundly condemns the methods of the Committee in charge of the preliminary work, their lack of engineering knowledge, and the selection of a floating bridge, which, it must be admitted, is tantamount to a confession of failure.

After making allowance for a possible bias in Dr. Waddell's feelings after the rejection of his proposal for a cantilever bridge with a central vertical lift span, it is impossible to read his remarks without an uncomfortable feeling that his summing-up—"A more badly handled bridge project than this would be difficult to conceive"—is only too true.

To sum up. The book cannot be said to add anything to Dr. Waddell's reputation. There is a great deal of valuable matter contained in it—Dr. Waddell knows the theory, practice and business of bridge engineering works better probably than anyone else—but there is too much chaff with the grain. A book one-third the size would have been extremely valuable, because it could have been published at a price and of a size which would have enabled individuals to buy it and use it. As it is, the good there is in it will be lost, because the book will take its proper place amongst other neglected mines of valuable information, on those forgotten shelves of technical libraries, where, deep in dust, lie the bound volumes of the "proceedings" of learned societies.

A.M.

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(1) SURVEY OF INDIA, PROFESSIONAL PAPER No. 20 (RECONNAISSANCE SURVEY FROM AIRCRAFT).

By LT.-COL. G. A. BEAZELEY, D.S.O., R.E.

(Price 2s. 6d.)

(2) PROFESSIONAL PAPER No. 21 (IRRIGATION AND SETTLEMENT SURVEYS, 1926.)

By MAJOR J. D. CAMPBELL, D.S.O., R.E.

(Price 2s. 6d.)

(3) THE TIDES. Part V of the HANDBOOK OF PROFESSIONAL INSTRUCTIONS (3rd Ed.) OF THE GEODETIC BRANCH.

By MAJOR C. M. THOMPSON, I.A.

(Price 3s. 6d.)

(Published by order of Colonel-Commandant E. A. Tandy, R.E., Surveyor General of India.)

(1) This is a very thorough and well worked out exposition of a method of visual sketching of the ground from an aeroplane. Colonel Beazeley had much experience of this method of map sketching during and after the War, and we fancy got all there was to be had out of it.

We can quite imagine it being useful in certain circumstances in war, but they would be limited. This kind of sketching from an aeroplane, travelling at 75 to 100 miles an hour, to be of any value would require a great deal of training and constant practice. But even granted all this, it is not easy to see how it could compete in any way with aerial photography using modern cameras and apparatus for rapid development and printing, unless perhaps in a climate which only presented rare opportunities for photography.

Another disadvantage, for use in war, is the comparatively low altitude, of about 6,000 feet, at which the sketching must be done. Also, we gather, the sketcher has to work in the full blast of the slip stream while travelling at, say, 90 miles an hour.

Though we could hardly recommend this method for general use, we are filled with admiration of the way Colonel Beazeley has worked out all the details connected with map sketching from the air.

(2) In India, some 25,000,000 acres are irrigated by canals. In a country of such great irrigation schemes, where large numbers of people have to be allotted land often in desert, or semi-desert, areas which the advent of water will convert into some of the most fertile tracts in the world, it has become necessary to lay out accurately and measure the land taken up by settlers.

It is also necessary to have an accurate system of levels required by the engineers in designing the system of canals and channels, so that the largest possible area may come under irrigation and may be available for settlers in the new colonies.

This report places on record new methods, only, which have been used for these purposes and which fall outside the normal work of the Survey of India, as everything pertaining to the latter has already been fully described in other professional publications.

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The process of marking out areas to be irrigated is known as rectangulation, which is defined as the dividing up of any portion of land surface into rectangles of fixed size, by accurate methods, and demarcating them with permanent marks. This is actually done by determining on the ground accurately, by triangulation or traversing, the corners of the largest rectangle which can subsequently be broken down by what we may call alignment and direct measurement, without further resort to triangulation or traversing. The large rectangles must, of course, be multiples of the smallest subdivision aimed at. The size of these primary rectangles depends on the nature of the ground, the length of the sides must not be greater than it is possible to see from one end a signal placed at the other, so as to admit of easy subdivision. In ordinary country, rectangles of about 2½ miles by 1½ miles have been found suitable.

The next operation after the area has been subdivided, which was usually carried by the Survey of India to 25 acres, was to determine the levels of the corners of these small rectangles and at points along their sides. From these, the whole area is contoured to 1-foot intervals and the resulting plans are used by the irrigation engineers for the design of the project.

Rectangulation carried out in a scientific and systematic manner, as now practised, has the great advantage that it comprises in a single operation the requirements of the Irrigation and Revenue Departments. It gives an accurately contoured representation of the form of the ground and it affords a means of allotting areas to colonists in a most exact manner. To be thoroughly effective, it is necessary to have the closest co-operation of these departments with the Survey of India.

The report under review contains a detailed account of the various operations involved, with numerous plates illustrating each step. It is, we believe, the most complete account which has yet appeared on the subject of Irrigation Surveys, and should be studied by all engineers who have to deal with conditions similar to those which prevail in India.

(3) When the tide-predicting machine, belonging to the Government of India, was transferred from the National Physical Laboratory, Teddington, to the Geodetic Branch office at Dehra Dun and not only the Harmonic analysis of tidal observations but also the actual preparation and printing of the tide-tables was undertaken by the Survey of India, it became necessary to revise the professional instruction on the subject. This volume is the result.

A short historical review is given of the various tidal theories, followed by a detailed account of the method employed by the Survey of India in predicting the tides, with a worked-out example to fully illustrate the process.

There is a chapter on tidal observations and a description of the tide-gauge used for the purpose by the Survey of India, at the various ports where observations are carried on.

The tide-predicting machine, and its working, is also described in detail with illustrations.

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Several improvements have been introduced by Dr. J. de Graaff Hunter since the machine was set up at Dehra Dun. The principal one appears to be the chronograph attachment by which the times of high and low water can be more accurately read, as the exact times are directly registered and have not to be estimated.

Anyone wishing to study the methods adopted by the Survey of India in the preparation of the tide-tables for Indian waters is recommended to read this work.

H.L.C.

THE PRINCIPLES OF UNDERDRAINAGE.

By REGINALD DAVID WALKER, M.C., A.R.C.SC., D.I.C., A.M.I.C.E.

(Chapman and Hall. Price 15s.)

Starting with a series of definitions of technical terms, the author proceeds to explore the sources and disposition of underground water, in such a way as to lead up logically to a statement of the objects and theory of underdrainage, and so to a general explanation of the methods of surveying and siting the various portions of the systems.

From the table of depths and frequencies of underdrains, it appears that he advises a somewhat wider spacing of the laterals than is usual in W.D. practice; the differentiation, however, between the systems to be adopted in localities of shallow and deep water table level is extremely sound, and follows logically upon the theories previously developed.

It is not quite clear why the anti-malarial theory of drainage is considered of sufficient general importance to warrant the devotion thereto of a separate chapter. It is, however, fully and logically treated, while the study of the economic aspect, although necessarily somewhat parochial, is of interest in demonstrating the wide range of circumstances in which superficial oiling is financially preferable to underdrainage.

It is unfortunate that the page headings throughout this chapter should have been so misleadingly abbreviated.

The following chapters, devoted to a detailed consideration of the underdrainage of ravines, flat lands, cuttings and embankments are full of interest, although it is a matter for regret that the author has focussed his attention so exclusively on conditions prevailing in the F.M.S. We infer from his preface that he desires his book to be of value to engineers generally, yet the inherent particularization of its application is perhaps most typically illustrated by the proportioning of the entries in Tables 3 and 4.

Though a similar criticism must be levelled at the economic data which are of purely local value, the general specification is good, and might well be used as a model in any quarter of the globe. As might be expected from the title of the book, the section dealing with open drains is less fully detailed, the use of Table 25 being hardly demonstrated at all; while the appendices, although serving to display the versatility of the author's knowledge, might with a small amplification of the main text have been quite reasonably omitted.

Judged from the aspect of a reference book, the index is adequate and the style and illustrations are admirable; one can only hope, therefore,

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that in his next edition, Mr. Walker will endeavour to enlarge the scope of his work and render it as valuable generally as it undoubtedly is now in the F.M.S.

A.D.C.

UNDERGROUND CABLE SYSTEMS.

By G. W. STUBBINGS.

(Chapman & Hall. Price 15s. net.)

The introductory Chapter I gives a very brief history of the subject.

Chapter II, on the "Physical Constants of Cables," is concise and to the point. It is unfortunate that the author uses "capacitance" and "capacity" to mean the same thing. This occurs throughout the book.

Chapter III, on "Cable Construction and Manufacture," contains some useful information. The remark, on page 20, that multicore cables often show economy over single core cables is quite true, but it should be emphasized that it is not always so, as a much larger current density is permissible in single core cables than in multicore.

No reference is made to "locked coil" armour, which, though somewhat more expensive, combines the advantages of wire and tape armour.

Chapters IV and V, on "Cable Laying and Jointing," IX and X on "Faults and Their Localization," and XII on "Plans and Records," are all well written and show the author's intimate acquaintance with the subject.

Chapters VI, VII and VIII deal with the theory of networks. The methods adopted to get the voltage drop in a distributor, on pages 67 to 69, appear unnecessarily complicated, but this may be a matter of opinion.

No reference is made to the voltage drop in the neutral of a 4-wire 3-phase system. The mains engineer who neglects this may find himself in difficulties.

Chapter XI is an excellent *précis* of our present knowledge of E.H.P. Cables.

Chapter XII deals with "Automatic Protective Systems," in a clear manner, although the value of the first few pages would have been much enhanced by the addition of a few sketches.

Chapter XIII, on the "Electrolytic Corrosion of Cable Sheaths," explains the matter clearly, from the supply company's point of view, but it is not brought out that it was the water and gas services which forced attention to the matter in the first place.

Chapter XV gives a brief treatment of the most common tests, and in conclusion are given three useful Appendices—I, "British Standard Test Voltages"; II, "Glossary of Terms and Definitions"; and III, "Current Carrying Capacity of Conductors Under Various Conditions."

The book is good value both to the student and the engineer, and the Bibliography at the end of each Chapter will be of great assistance to the reader who desires to pursue the subject.

The following slips and misprints are noted:

Page 12, C_s for C_c in three places; l is shown as a numerator, instead of as a denominator, in the third formula on page 13; page 67, line 10,

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$\sqrt{3}\,V$ for $\sqrt{3}$. V. line 20, $\frac{\text{"V"}}{V}$ for $\frac{\text{"V"}}{100\,V}$; page 71, line 13, the word "twice" should read "4 times"; page 77, $\frac{M}{S}$ shown for $\frac{B}{S}$ in two places; page 82, line 22, the word "network" is omitted; page 85, the letter "o" is omitted from the righthand diagram in Fig. 42; page 91, line 16, "x_2" for "x_1"; page 175, line 8, the insulation resistance is given as 2 ohms: this obviously means 2 megohms.

W.M.N.M.

UNDERTONES OF WAR.

By EDMUND BLUNDEN.

(R. Cobden-Sanderson, London. 1928. Price 10s. 6d. net.)

The literary qualities of this volume and its supplement of "poetical interpretations and variations," have already been the subject of generous appreciation in the Press. But the book has a real military value, too.

It is the story of the personal experience of an infantry officer in France from the spring of 1916 to the spring of 1918. In the words of one of its reviewers "it is an invaluable document." This is true, because it gives us a wonderfully written description—not overstated—of the life of many another such subaltern in the mud of Flanders and the chalky slime of Artois, and it is well that it should have been written—lest we forget.

The author, little more than a schoolboy fresh from Christ's Hospital in Sussex, joined one of his county battalions in the trenches near Festubert, and served with it, or the brigade of which it formed part, in all the best-known sectors of the British Front. Going through all the experiences which a subaltern of more than average ability, courage, physique—and luck—went through in command of a platoon, a company, then as "maid of all work" attached to brigade headquarters—signals, bombs, musketry, rations, transport, intelligence—and for a time as "town major" of a monstrous dugout in the Ypres Salient, he is well qualified to speak. He gives us a wonderful description of it all, its joys and its horrors. The joys of the rest billets, the roadside *estaminet*, the concert party, leave and lorry-hopping; the horrors of German hates, gas, and air bombs.

A man of independent character, he was "up against it" more than once with his superiors and "the staff." He gives us a very good idea of the attitude of the temporary officer to the powers that be, softened though it was by time, knowledge and intercourse as he rose to positions of greater responsibility. It is a book to be read by those who aspire to command, for it shows the necessity of never forgetting the effect of an order on the man in the line.

One of the best points in the book is the evidence of the affection of the good regimental officer for his men and of the good commanding officer for "his children," as the French would put it.

The author is a poet who has made his mark, and the supplement contains a number of short poems, written at the time and after. One wonders "how he did it" in the circumstances in which he lived.

H.B.-W.

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MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1928. TOME II.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée belge. The operations of the Belgian Army during the month of November, 1914, up to the date of the fall of Dixmude (Nov. 10th), are described in these numbers of the *Bulletin*. Events up to the evening of Nov. 3rd are contained in No. 1; those of Nov. 4th and 5th in No. 2; and those of Nov. 6th to 10th inclusive in No. 3. At this period the enemy had taken up a purely defensive attitude along the front held by the Belgians, and was carrying out a re-grouping of his formations with a view to reducing to a minimum the force to be retained on the Yser front, since it was no longer possible to carry out operations of major importance on this section of the line. On Nov. 1st the Germans held possession of the line of heights, which, between Messines and Wytschaete, commanded this region of the country; from this date onwards only some slight local advances were made by the enemy, and it soon became apparent to the German High Command that its aims could not be achieved by an offensive on the part of the troops under von Fabeck. However, in order not to abandon at once the attempt to break through the entente front S. of Ypres, and also with a view to avoiding the assumption of a purely defensive attitude on the Western Front, a reinforcement of four infantry divisions was sent to General von Fabeck, and a reinforcement of three infantry divisions was also allotted to the Ypres region, and placed under the Commander of the German III Corps. It was the intention of the German High Command that the Linsingen Group (the XV and Plettenberg's Corps) should launch a powerful attack to the E. of the Ypres Canal at Commines on Nov. 10th. At the same time, von Fabeck's troops were to recommence active operations to the westward of this canal, whilst the German Sixth and Fourth Armies were directed to hold the entente troops in their front by also assuming the offensive. The German Fourth Army delivered a violent attack against the Dixmude bridgehead on Nov. 10th, and carried it. The attack of the Linsingen Group did not mature until the 11th; heavy fighting resulted, but the Germans made no substantial progress. These operations constitute the last important offensive of the Germans in 1914 in Flanders; they were brought to a halt. The fronts of the opposing forces now gradually began to become stabilized, and the period of trench-warfare commenced. During this period the French also sent reinforcements—five infantry and three cavalry divisions—into Belgium, and, with their support, the Belgians assumed the offensive simultaneously with the enemy's aggressive movement. Minor local successes were alone obtained by the French, whose front also became stabilized.

During the November operations, French troops were pushed forward into the section of the line held by the B.E.F., and eventually divided it into two separate parts. Between Nov. 15th and 22nd, the Ypres

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Salient was taken over entirely by French troops, and the B.E.F. was moved further S., taking over the defence of the entente front from Wytschaete to the la Bassée Canal.

The more important Orders issued during this period are set out in the original articles, and a short account is given in No. 3 of the *Bulletin* of the inundations carried out between Dixmude and Fort Knocke on Nov. 10th, and subsequent days.

Du rôle de l'armée de campagne et des forteresses belges en 1914. Parts 5 to 7 inclusive of the article by Lieut.-Colonel Duvivier and Major Herbiet are published successively in these numbers of the *Bulletin*. In Part 5, the authors of the original article describe the manner in which the operations of the German First, Second, and Third Armies were influenced by the existence of the fortified position at Namur during their eastward advance. A table is given showing the strength of the German troops held at Namur and in the Entre-Meuse by the Belgians on each of the days from Aug. 20th to 25th inclusive. The French Fifth Army, it is claimed, was, during the fighting on the Sambre and the Meuse, able to manœuvre with a degree of freedom which would not otherwise have been possible only by reason of the fact that the fortified position of Namur afforded secure protection to the flanks of the French troops engaged with the German forces in this region. The Namur forts hindered the Germans in their pursuit of their enemy in the Entre-Meuse and the Meuse. Further, the Belgian troops which had withdrawn successfully from Namur, and retreated southwards into France, by their presence in the neighbourhood of Bioul, covered the outposts of the French I Corps, then between Ermeton and Anthée, and also the right flank of the French X Corps, during the night of Aug. 23rd/24th. These Belgian troops also opposed the heads of the columns of the German Second and Third Armies engaged in pursuit of the French, and played the *rôle* therefore of a rear-guard to their retreating allies.

In Part 6 is begun the account of the operations in the Belgian theatre that followed the phase of the campaign, known as the *Bataille des Frontières*, which ended on Aug. 23rd. An account is given therein of (*a*) the movements of the Belgian Army, and (*b*) the *rôle* played by it, during the second phase of the war in the Belgian theatre ; particular attention is called to the influence which the fortified position of Antwerp had on the operations during the period from Aug. 23 to the victory on the Marne, and to the Battle of the Aisne. The first sortie from Antwerp (Aug. 25th–26th) is described, and an account is given of the circumstances in which von Moltke created the German Seventh Army under von Heeringen on Sept. 5th ; it became known as the " Belgian Army," and was directed to adopt protective measures against attacks on the Germans from Antwerp, and to drive the enemy from Western Belgium and the adjacent region of Northern France.

The account of the operations in the neighbourhood of Antwerp is continued in Part 7. The second sortie from Antwerp (Sept. 9th to 13th, 1914) is described in some detail, and the reactions of the events in Belgium on the Battle of the Aisne are discussed. An account is given of the Siege of Antwerp and of the Belgian retreat to the Yser. The influence that the resistance put up by the troops in Antwerp had on the events which took place in Flanders in October, 1914, is also discussed.

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Utilité et rôle de la cavalerie. This article, which appears in No. 1 of the *Bulletin*, is based on the evidence given at its 15th meeting, on Feb. 17th, 1928, by Lieut.-General de Longueville before the *Commission Mixte* appointed to report on the organization, etc., of the Belgian Army. It is an able and vigorous defence of the cavalry arm, and contains powerful arguments, supported by references to the important part played by the entente cavalry in various theatres during the Great War, for the retention of this arm in the Belgian Army.

Notions générales sur les transports militaires par chemin de fer. This article appears in No. 1 of the *Bulletin*, and is contributed by Major Lebert, of the Belgian General Staff, who points out that prior to the outbreak of the Great War a number of military writers had foreseen that railways would play a prominent part in wartime. However, it was practically only the use that would be made of this means of transport during the mobilization and concentration periods that had been closely studied; sufficient experience was not then available to permit of definite instructions being drawn up as to the manner in which railways should be utilized during the progress of a campaign. Major Lebert states that, contrary to what was assumed in Belgium would be the case, the Great War has shown that for the transport services an organization is required which consists partly of a military element and partly of a civilian technical element. The original article has been contributed with a view to providing soldiers with some general ideas on the use of railways for military purposes, and to show what results can be expected, from this means of transport, particularly where a small army is concerned.

Napoléon Ier. Sa vie et son œuvre. The concluding part of the article under this title contributed by Major F. Delvaux is published in No. 1 of the *Bulletin*; the period immediately prior to the creation of the Empire and the Imperial Régime up to the date that final disaster overtook the Emperor on the field of Waterloo, are dealt with.

Les Fortifications permanentes actuelles de l'Allemagne. This article, which appears in No. 1 of the *Bulletin*, is based on a contribution with a very similar title which was published in the *Revue Militaire Française* for April, 1928. The position of affairs on the Western Frontier and on the Southern and Eastern Frontiers of Germany are briefly described. The terms of Arts. 180 and 196 of the Treaty of Versailles, which forbid the Germans to strengthen their frontier defences, were, it was alleged, being violated by them. In consequence, negotiations were entered into by the Powers interested with a view to clearing up the matters in dispute, and resulted in an agreement on the subject. The terms of this agreement—dated January 31st, 1927—set out the interpretation to be placed upon the two Articles above-mentioned, and is reproduced, together with the text of these Articles, in the original article.

Les Chars de Combat. Part 6 of the article under this title, by Major Liévin, is published in No. 2 of the *Bulletin*; particulars are given therein of tanks in use in the Italian and British Armies.

Historique du Génie. The first two parts of an article on this subject, by Lieut.-Colonel Coppens, appear in Nos. 2 and 3 of the *Bulletin*, attention being called to the very considerable increase that has taken place in the engineer arm in modern armies during the past quarter of a

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century. In the first part, the history of the arm from the date of its creation in very ancient times down to the period of Maurice de Nassau is traced: and the nature of the work entrusted to this arm in the campaigns of far distant days is also briefly touched upon.

The second part contains brief biographical notes on Maurice de Nassau (1567–1627), and Sebastien le Prestre de Vauban (1633–1707). It was during the wars of Philip II., and his successors, in Holland (1566–1625) that a great impetus was given to developments affecting the art of the military engineer. It was largely due to the influence of the Princes of Nassau that the famous school for the study of fortification and siege warfare was founded in Holland. Maurice de Nassau took a deep interest in this school, and did much to further its development. In the account given of Vauban's life, stress is laid on the great difficulties he had to contend with, and the prejudices he was up against when he attempted to create a permanently organized Corps of Engineers; his efforts in this direction only met with partial success.

Sappers will find much in these articles to interest them.

Le transport de nos chars de combat. The original article, which appears in No. 3 of the *Bulletin*, is contributed by Lieut. de Greave, who points out that the low speed at which tanks travel ordinarily under their own power is a grave disadvantage, and detracts from their value as a military weapon. He describes some of the steps which have been taken to remove the disability in question, and gives particulars of motor-vehicles which have been designed for the rapid conveyance of tanks from one locality to another distant one. The article is illustrated.

W.A.J.O'M.

COAST ARTILLERY JOURNAL.

The September number contains a long article on the Vicksburg campaign for the Mississippi River, by which Grant cut the Southern States in two and interfered with their reinforcements and supplies. In this he was greatly assisted by a daring raid carried out successfully by Grierson with a small brigade of cavalry on the Confederate communications: this was one of the great cavalry exploits of the War, and prevented early concentration of the Southern reinforcements, and thereby contributed largely to the success of Grant's major operation.

Also an interesting story of the long fight for the possession of the Coast Forts in Connecticut, between the Dutch and English, and later the Americans, from 1614 to 1781.

The Tacna-Arica question, the Alsace and Lorraine of South America, is described, and shows how an ill-considered doctrine of acquisition may lead a country into difficulties quite unforeseen and unforeseeable.

By the Monroe doctrine, the United States declared her intention to guarantee all Republics of the Western Hemisphere from aggression or interference by European Powers. From this it has followed that she has announced her intention to assist by arbitration, and if necessary by armed intervention, in maintaining stabilized government therein, in settling international disputes and in furthering their progress and welfare.

Tacna-Arica is a territory bounded on the north by the Peruvian oil

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fields, on the south by the Chilean nitrate provinces of Iquique and Antofagasta, and on the east by Bolivia, which last country has no longer any outlet to the sea. In 1880, Antofagasta with its seacoast was Bolivian, while Iquique and Tacna-Arica belonged to Peru. In 1883, as the result of a successful war of aggression, Chile took Antofagasta from Bolivia and Iquique from Peru, together with the control of Tacna-Arica from the latter, for a period of ten years, after which a plebiscite of the inhabitants was to determine whether the province should revert to its original owner or remain with Chile.

The territory is of small intrinsic value at present, but each country desires it as a buffer to protect her richer fields from the cupidity of her neighbour. And in ten years many changes may be wrought under such conditions.

At the end of the period of waiting, neither of the countries would agree to the terms suggested by the other for the plebiscite. Chile demanded that all the Chileans then in the province should be given a vote, and thereby hoped to swamp her opponent. Peru, on the other hand, contended that only the original residents should be allowed to vote. The dispute was offered to the Pope and the King of Spain for arbitration, but both wisely declined the invidious invitation.

After twenty-seven years of futile discussion, during which Chile was obviously gaining ground at the expense of Peru, the latter severed diplomatic relations with the former. After the Great War Peru, as an "associated nation," disavowed the old treaty and submitted the case to the League of Nations. This publicity did not suit Chile at all, so she invited Peru to reconsider the question. Peru promptly replied with a proposal that the United States should be asked, under the terms of the Monroe doctrine, to arbitrate forthwith. As this arrangement then entirely suited the creed in vogue at Washington, the final claims and counter-claims were filed and presented to the President in 1922.

The award was eventually published to the effect that the plebiscite must be held: that during the plebiscite all power must be in the hands of Chile: but that the Commission should consist of a Chilean and a Peruvian, with an American to act as president. The result looked like a walk-over for Chile, and was taken by both sides as such. Peru immediately entered a protest, and it began to dawn upon the United States that a quicksand might be yawning in her path.

General Pershing was detailed as American member and president of the Commission; he directed that the Peruvians should be granted equal rights with the Chileans, and that a large number of Chilean troops should be withdrawn from the province before the plebiscite was held. This appeared to be but the pious aspiration of a cloistered mind.

April 15th, 1926, was named as the date upon which the final vote was to be cast. Unfortunately, General Pershing fell ill and had to return to the United States before that date, and General Lassiter was detailed to replace him. The new president arranged that every polling district should be under the supervision of a United States Army Officer as president, with a United States Sergeant as secretary and another Sergeant as sergeant-at-arms, besides the Chilean and Peruvian members. He furthermore instituted a school, at which all the United States officers and N.C.O.s received a month's careful instruction in their duties and

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responsibilities, showing that he thoroughly realized the difficulties to be overcome.

The day arrived and, as was expected, the Chileans did their best to control and influence the voting by registering all the Chilean inhabitants and suppressing the Peruvians, so that, in many places, rioting and demonstrations occurred. In the end, General Lassiter became convinced that a fair plebiscite was quite impossible to obtain.

As a result, the Tacna-Arica question is not yet settled, and promises to cause much hardship and heartburn in the future. It would further appear that favourable conditions for a fair election are impossible at present unless—and herein opens the pitfall in the path—the whole territory is neutralized by a benevolent and capable foreign power. This condition at once produces the spectre of Cuba, the Philippines, Nicaragua, and points to the same result.

Will Peru rather demand permission to put her trust in the League of Nations, and, if so, how will the United States view the incursion of the League's activity into the southern part of her continent?

The October number begins with an article on Seacoast Defence to stress the necessity of the maxim that a fortress must not be commanded by the Senior Coast Artillery Officer while he commands the Coast Artillery as such. In other words, territorial command by a functioning artillery officer is unsound. The author points out that the United States Training Regulations and Artillery Regulations do not bear out this maxim.

There follows a description of the genesis and growth of the War Industries Board in America during the Great War, with the following functions:—

1. The creation of new facilities and the disclosing and opening up of new and additional sources of supply.
2. The conversion of existing facilities, where necessary, to new uses.
3. The studious conservation of resources and facilities by scientific, commercial and industrial economies.
4. Advice to the several purchasing agencies of the Government with regard to the prices to be paid.
5. The determination of priorities of production and delivery, and of the proportion of any given article to be made immediately accessible to the several purchasing agencies when the supply of that article is insufficient, either temporarily or permanently.
6. The making of purchases for the Allies.

The writer concludes by stressing the utmost importance of retaining a peacetime organization, based on the experiences of the wartime agencies, to be formed in suitable divisions and sections, so that it might be possible in case of future war to create promptly an organization of all the industries and resources of the nation. The principle of the selective draft to be applied to every grade, to the business army as well as the fighting forces, so that the whole life of the nation, economic as well as military, shall be conscripted.

Thus may be avoided that enemy who can undermine the will to war

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so rapidly, the popular conviction of widespread exploitation and profiteering.

A short sketch of the military situation of Japan describes the racial characteristics of the Japanese as resourceful, emotional and still almost fanatic, less nervous and better able to endure discomfort than the Anglo-Saxons, but with smaller physical endurance. They have no sense of humour, and are not pioneers. The increase of population is alarming to an already overcrowded nation; a family of ten children being considered only medium-sized in Japan; but she can no longer feed them, and she has already been obliged to import rice.

In an article on "War and Human Nature," the following quotation may be of interest:—

"There are nearly always at work in any nation, whether at peace or at war, certain constant forces tending in the direction of autocracy, caste formation and an aristocratic differentiation, a pyramiding of the social structure, a conification or pointing upwards, making the upper classes fewer in percentage to the total and at the same time more aloof . . . It depends upon the gigantic force of heredity, and upon the fact that in marriage, like tends to mate with like. . . . A savage people is never highly conified.

"With the accumulation of property, however . . . there takes place the handing on of riches to the next generation. Men of wealth, success or ability bring their children to marry one another. Biological heredity is at work, and by a process of selection, a caste is formed of individuals endowed with an excess of precisely those qualities that their ancestors have exhibited during their own lives, namely, ambition and a love of power and leadership, glory and family pride.

"These forces may culminate in aristocracy. When they do, we have a national structure very well adapted to belligerency and very prone to fight.

"As far as the evidence from European history is concerned, if war is diminishing, it is not diminishing much . . ."

D.M.F.H.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*March–April*, 1928).—*The Use of Artillery in the* 11*th Isonzo Battle.* Lt.-Col. Heinzel gives in detail the events of the 18th–22nd August, 1917, as they affected the artillery group under his command on the front of the 48th Austrian Division. He makes out a good case for his claim that the artillery had a considerably larger share than usual in the success of this purely defensive battle. His group had also their share of the casualties, viz., 50% of the personnel killed and wounded, and eight guns destroyed by direct hits.

The author also points out that many a good fight is insufficiently appreciated because of its having no strategic effect. The case in point is the attack by the Italians on the Karst plateau, which he describes. It does not, however, follow that a successful defensive battle which leaves the opponents in the same relative position as before has no

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strategic effect. The tactical success in this instance may avert strategical disaster, it may have a most important negative strategic effect. A more striking example, because the negative strategic effect is more apparent, was the attempt on Béthune made in April, 1918, by seven German divisions against the British 3rd, 4th and 55th Divisions, when it had become imperative for the Germans, as a first condition of a further advance on and beyond Hazebrouck, to widen the breach of their breakthrough.

French War States. From the *Revue militaire française* certain interesting figures are taken of the yearly average numbers of French combatants in the field :—

1915	...	2,120,000	1916	...	2,210,000 (includes one extra class).
1917	...	2,000,000	1918	...	1,702,000 (includes the 1919 class.)

The employment of French Divisions in 1918 is also worked out, from which it appears that on the average each division spent 27% of its time on a fighting front, 46% on a quiet front, and 27% " in complete rest." The choice of the latter expression as a paraphrase for " out of the line " is so unhappy as to suggest that the author of it must himself have remained in the line during the whole war ! The figures are here utilized for the purpose of adding one more leaf of glory to the laurels of the Germans, on the grounds that they got no rest at all—a statement to be accepted with reserve.

Railways in War, by Gen. Ratzenhofer (concluded). The principles of an appropriate and systematic management of mass-transport by the military railway authorities are timely and adequate information of the plans of the G.H.Q., and an exact knowledge of the capacity of the railways, of the composition, distribution and march-readiness of the troops, and of the requirements as regards detraining.

This exact knowledge of the " own situation and intentions " was completely available during the preparation for war and at the commencement of the forward movement. After the first few weeks of war, through a lack of liaison in high places and through enemy action, it was disturbed and in definite areas often completely lost.

Every success in dealing with mass-transport in war rested upon exact attention being paid to these principles, and every failure was due to their non-observance.

All mobilization schemes were based upon the railway-schemes drawn up by the military and civil railway authorities in peace and revised yearly, in winter. The railways had their work mapped out for them in peace, up to the 20th day of mobilization in back areas, and in forward areas, on account of secrecy, up to the 5th day. This very thorough piece of work afforded the only possibility in peace of practising together those military and civil officials, who in war would be entrusted with the direction of the military railway staffs.

What happened was that Scheme B, partial mobilization and forward movement against Serbia, started on July 27th with about 70 trains a day. On August 2nd, preparations were started to change over to

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Scheme RB, to be followed on August 4th with complete mobilization against Russia. By August 16th, there were 800 trains of 50 wagons each —the length of 250 miles of track—in daily movement according to plan. The salvation of the scheme lay in a programme prepared through years of work in peace.

Nothing to compare with this orderliness ever happened again. Improvisation was henceforth stamped on all movements.

Light Machine-guns, by Capt. Däniker, Swiss Army. The light machine-gun has a very definite position to fill, and nearly all armies are at present occupied with this question. The author lays down its essential requirements, and then the limitations which must be imposed upon it. He comes to the conclusion that efforts to improve the light m.g. by assimilating it to the heavy m.g. are a complete mistake, since they rob the light m.g. of its character and add to it a complexity which prevents it from solving the battle-tasks for which it was created.

The next article, " The Light Machine-gun Breda," compiled from a pamphlet of the Società Italiana Ernesto Breda in Milan, gains thus in interest, since it describes a m.g. of 20 lb. weight and having the rifle appearance, which, being a bolted recoil-loader with movable barrel, introduces for the first time among light m.g.s properties hitherto restricted to heavy m.g.s. The remark, " for the first time," would appear to ignore the Madsen and the Swiss light m.g. 25 (Furrer), which have already left the gas-pressure loaders, but the claim remains of having improved the light m.g. while retaining its character.

Armoured Cars, by Major Heigl (*continued*). The instalment in this number is chiefly remarkable by containing photographs, sketches and certain points and figures concerning the Czecho-Slovakian armoured-cars, P.A. I and P.A. II (known, from its shape only, as the Tortoise). P.A. III has also appeared, differing from P.A. II in that its outside curves are provided by armour built up of separate small pieces, triangular and four-cornered. This change has made possible a reduction in weight from $6\frac{1}{2}$ to 5 tons. Major Heigl calls the P.A. II " the best armoured car we know," which probably means in existence.

The remaining photographs are of older types of armoured car : the Bianchi (Italy and Hungary), the Ansaldo (Italy and Czecho-Slovakia) and the Austin (Russia and Poland), of a late pattern of Citroën-Kegresse chassis, and of a Pavesi (high-wheeled) armoured tractor negotiating a trench. The two latter are to illustrate short notes on these systems. Six-wheeled vehicles are also dealt with, and the principle of the Pavesi patent, showing how flexibility is given in spite of the large heavy wheels, is shown by sketches.

Modern Anti-tank Weapons. This article, illustrated with several sketches, is based upon an article in the December number of the *R.T.C. Journal*, but has been considerably enlarged by Major Heigl since. The photographs are good and clear. They include : the 13·2 mm. Hotchkiss m.g. on a light field carriage ; the 2 cm. gun built at the Hague for use on submarines, and later mounted on a German maxim m.g. carriage for use against armoured-cars ; the 37 mm. Bofors infantry gun ; the 47 mm. Bofors as anti-aircraft gun ; and the new 70 mm. Schneider infantry gun.

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(*May–June*, 1928).

The Plans of Operations of the Central Powers for the Autumn Campaign, 1914. This is one of Capt. Wisshaupt's excellent articles, in which he combines instruction with history by discussing the problems and choices which lay before the Commanders. The period covered, from the 18th September to the 27th October, is full of interest, since it starts from the time when the Russian "steam-roller" stopped on the San, and the Austrians were reinforced by Mackensen's (9th German) Army from East Prussia, and includes the successful Austro-German advance to the line of the Vistula, and the Russian movement from the north, which turned Mackensen's left flank and caused the general retreat.

The Austro-Hungarian Operations for the Occupation of the Ukraine, 1918. In Christmas week, 1917, after three years' service in a German Army, the 12th Austro-Hungarian Corps was transferred from Lithuania to Eastern Galicia. There they received two Austrian divisions to replace three German divisions, which, released by the armistice with Russia, were already on their way to the Western Front. The 12th A.H. Corps was then used for seizing the Ukraine, which, with plenty of fighting against the Bolsheviks, they carried out as follows:—28th Feb. to 18th March, operations between the Dniester and the Bug, and the capture of Odessa; 19th March to 13th April, operations between the Bug and the Dnieper, and the capture of Ekaterinoslav; 18th April to 13th June, occupation of the Donetz coalfields, the Crimea and Sea of Azov. From June to November they assisted in the establishment of the Ukraine Government.

The article deals with a new method of conducting war—railway warfare; and for this, since the Russian railways were cut off from the Austrian by a change of gauge, everything had to be improvised. The rolling-stock was in a deplorable condition, couplings were defective, and many of the locomotives "swayed like overladen hay-wagons." The Austrians, with improvised railway staffs, would have fared even worse than they did, but for the Russian railway personnel—unpaid for months—who stuck to their posts and served their new masters. Trains in taking troops forward had to follow one another by sight; accidents were unavoidable; and the first train always ran a good chance of being ambushed.

Odessa itself was taken in this fashion, after an airman had reported 15 larger warships and 20 torpedo-boats in the harbour. This fleet saved much embarrassment by putting to sea on the arrival of the Austrian troops in the town, all excepting one cruiser, which, delayed only for a repair, had fortunately disappeared by the next morning!

The Building of Heavy Floating Bridges, by Lt.-Col. Kern. The object of this article is to introduce to Engineer officers the building of heavy floating bridges which, on account of the time they have to last, must be built so as to allow for floods. The design and execution of such bridges demands knowledge which is not to be found in text-books (*vide* note below), but which has been gained by practice in war.

An example of a bridge which was built over the Save above its junction with the Drina is then set as an exercise.

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Data :—River 343 metres between banks ; right bank 4·5 metres, left bank 4 m., and flood-level 3·5 m. above present water-level ; lowest water-level 2·5 m. below P.W.L. ; right bank, sandy, slopes at 1 in 5·5 for 54 m., will take 5 pile-trestles, 9 m. centre to centre ; left bank, loamy, vertical 4 m. and then falls 1 in 5·5, will take 3 pile trestles, as above.

Width of roadway, 6 metres.

Max. load on each trestle, 36 tons.

Max. load on each road-bearer (9 m. long, 8·5 m. between points of support) starting at left-hand point of support, wt. *nil ;* at 1·05 m., wt. = 2·25 tons ; at 4·25 m., wt. = 4·5 tons ; at 7·45 m., wt. = 2·25 tons ; at 8·5 m. (right point of support) wt. *nil.*

Available : Cut timber as required.

16 lighters, 58 m. long, 8 m. broad, 2·2 m. water-line to gunwale unloaded, made up in pairs, 24 m. from outside gunwale to outside gunwale. A cut to be arranged for.

Ordinary pontoons are available to carry the ramp of left bank where the water is too deep for trestles.

Labour available :—Engineers, 5 officers, 5 serjts., 150 other ranks ; unskilled, 2 officers, 160 other ranks.

Required : Design, calculation, details of ramps, details of floating portion, materials required, tools required, working parties, time-table.

The exercise has been printed separately and can be obtained with full solution from M. und T. Mitteilungen, Stubenring 1, Vienna I.

Note.—The *German* Heavy Bridging Manual, H. Dv. 222 Part III a, however, goes into the subject thoroughly. Publisher, E. S. Mittler & Sohn, Berlin.

Prize Competitions as a part of Individual Training, by Lt.-Field-Marshal von Ostrymiecz. These competitions, now universal in the Austrian army, were, in the author's division at least, held periodically during the War. A junior N.C.O.s' School consisting of two men per company throughout the division was the focus, from which there radiated into the trenches a freshness and an awakened interest in the sporting side of weapon efficiency. From individual improvement rose a higher standard of weapon efficiency all round, expressing itself in two directions, less casualties suffered and more casualties caused.

The Development of Artillery Material since 1914. Major Heigl resumes his series with an article on " Heavy Guns on Position-mountings." As he excludes naval guns, coast-defence and other fortress artillery, he is dealing with the small, but very interesting, class of heavy guns used in land-warfare on movable position-mountings. The use of heavy artillery before the War was supposed to be the bombardment of fortresses, since the mobility of long-range guns ceased at the 6". In fact, the problem of mobility above the 6" was so difficult to solve that even with the naval 6", railway-mountings were used by all three powers on the Western Front—France, England and Germany. Hence, apart from railways, the number of mountings to be found in all armies is small.

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The descriptions of three very different mountings are then given, with drawings and photographs :—

(1) The *affusto a coda*, or mounting consisting of two girders pivoted in rear by a heavy spur sunk in the ground, of the Italian 152 mm. L45 gun.
(2) The solid platform, taking to pieces for transport and requiring a pit 4′ 6″ x 17′ 6″ x 20′, of the Austro-Hungarian 24 cm. gun M16.
(3) The double recoil of the French 220 mm. Schneider gun M17.

Finally, on the plea that so many apparently immovable coast-defence guns were used in the War on different land fronts, the article closes with a description of the American 16″ gun, of which the shell weighs one ton and can penetrate 14″ of armour at 31 miles. Ten of these guns are in position : New York 2, Boston 2, Sandwich Islands 2, and Panama 4. Eighteen more are being provided, for Panama 4, and the remainder for San Francisco and Chesapeake Bay.

War and Criminality. The Carnegie Institute for Peace has left no stone unturned in its efforts to show up war in its worst aspects. In pursuit of this object the Institute brought about the appointment of a Commission for investigating criminal charges against officers of the old Austro-Hungarian army.

It will be of interest to officers of all armies, but it will not surprise them, to learn that of 484 such complaints unearthed by the Commission, eight only led to criminal proceedings, and of these six resulted in acquittals.

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HEERESTECHNIK.

(*April*, 1928).—*French Instructions on the Organization of Terrain.* This article consists of copious extracts from and notes on Part I of the *Instruction provisoire sur l'organisation du terrain*, which deals chiefly with the principles of field fortification, while Part II, to be noticed later, enumerates and describes the various works and gives instructions as to their execution.

The German reviewer finds that the general principles of the French Instructions agree closely with those laid down in the corresponding German manual, H.Dv.276, Part I. When he comes to details he finds certain differences worth pointing out. He objects to the organization by regulations of a defensive front into an advanced position, *position des avant-postes* (which the Germans only say " may " be desirable), a position of resistance, consisting of a main line, *ligne principale*, (corresponding to the German main line of combat), a line of supports and a holding-up line, *ligne d'arrêt* (which the Germans do not know). Exception is also taken to the provision of a centre of resistance as part of the defensive arrangements of the battalion, and to its sub-division into company, section and group strong points. Finally, he is not pleased with the continual emphasis which is laid on the importance of connecting up all posts and centres by means of a network of parallels and communication-trenches, provided upon a scale so lavish as to render it

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impossible for hostile aircraft to determine which are the occupied and important parts of the position.

Two omissions are considered striking, that no mention is made of the necessity for adequate drainage of a trench system ; nor any of the value of inundation for creating obstacles.

The Technical Development and Present Position of the Six-Wheeler. This article of 18 pages, with nearly 40 photographs and drawings, would constitute a pamphlet in itself. Dismissing the Chevrolet as not a true six-wheeler, since its third axle was not driven, the rise of the six-wheeler is traced from the Renault of 1924, designed to show that a wheeled car could cross the Sahara as well as the Citroën-Kegresse, through the successive improvements of the Krupp 2-tonner, Daimler-Benz, Mannesmann-Mulag to the Krupp 8-tonner and the Büssing. The whole makes a suitable introduction to the W.D. specifications for a medium 6-ton lorry, and the requirements of 6-wheelers as stated by Major Kuhne in a lecture at the Institution of Mechanical Engineers. Up to date (April, 1928) twelve firms, in response to the War Office appeal, have produced 31 different types of six-wheeler, of which fourteen have been passed as fit to earn the Government subsidy of £120.

Sound-Ranging and Flash-Spotting in the Swiss Army. That a non-combatant in the Great War should have anything on this subject to teach the Germans may be surprising. The explanation appears to be that the Swiss Army was enterprising enough to take the subject up in 1917, and must have learnt much from the French.

The origin of sound-ranging is due to the astronomer Nordmann, who in November, 1914, from the Paris Observatory located a battery carrying out trials. His success was immediately exploited, and only three weeks later the first German battery was located by this means on the Soissons front.

In 1922, the Swiss Army formed a Sound-ranging and Flash-Spotting unit for every artillery brigade. As sound-ranging results are affected by temperature, the degree of moisture in the air, and above all by the strength and direction of the wind, meteorological instruments and personnel are included in the detachment's equipment.

The effect of the wind on range-measurements is so great, and wind conditions are so difficult to determine, that flash-spotting is the method preferred, especially at night. As, however, sound-ranging alone is possible in foggy weather and in wooded country, the two systems work hand in hand.

Social Politics and Technics in the Service of National Defence. Considering it undeniable that Germany's mistakes in social politics led directly to the loss of the world-war, the author indicates a number of questions regarding the regulation and organization of labour, "the home-army," which must be investigated and settled in peace in order that the nation may be able to put forth its whole strength in war.

(*May*, 1928.)—*Wireless Novelties at the Leipsic Fair*, 1928. In newspaper fashion this article starts with births and deaths. "The Funnel Loudspeaker is dead." This is true, and it was the Cone Loudspeaker which killed it. "The most important of all novelties is the

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Thermo-Battery." This hoary centenarian should not, however, have crept in amongst the births. Nevertheless, it is interesting to note how conditions have conspired, after over 100 years of waiting, to give it a place in the world. Appearances, too, were all against the thermo-electric battery, holding as it does a firm place amongst the world's most inefficient converters. The specimen exhibited at Leipsic, the "Stub," takes 200 watts from the mains and renders 1·6 watts (4 volts and ·4 ampère). The Stub is manufactured by Strauss and Berliner, 20 Prinzessenstrasse, Berlin, measures about 12" x 10" x 9", weighs 11¼ lb., and consists of 176 bismuth alloy and antimony alloy couples. It can be heated also by gas, oil or spirit. The conditions which have given the thermo-battery a sphere of usefulness are broadcasting reception by amateurs, all having electrical energy readily available from plug-contacts for heating purposes, and indifferent as to the inefficiency of conversion, but desirous of being free from accumulator troubles, dry-battery troubles and transformer noises, and hence ready to welcome a source of energy for their sets, which requires no charging, which requires no attention, which does not run down, and which contributes no unwelcome noises of its own.

A new rectifier by Siemens-Shuckert utilizes the property that from cuprous oxide to copper a current will only pass in one direction. It is built up complete with a small transformer, leads and plug for taking from house-lighting mains, and is intended for accumulator charging up to ·5 amps. A larger size is promised for large batteries up to 10 amps.

The Nife-Stahl Company showed accumulators without sulphuric acid. The cells are of cast dagenite and contain an alkaline electrolyte. They need no outer covering.

Telefunken showed grid-screen valves which reduce the anode to grid capacity to a few hundredths of a centimetre, so that effective H.F. amplification of waves less than 600 metres is claimed: amplification-factor, 500.

Something entirely new was shown by the Metallicator Company. This firm concerns itself with the metal spray for weather protection, spraying molten zinc, tin, aluminium, copper, etc., from a blast pistol. For wireless instruments the same method of spraying has now been applied to wood and insulators, so that it is possible to spray the connections of, say, a wireless receiver on a sheet of vulcanite, and thus exclude all possible errors in connecting up. Wiring disappears, and without labour, mistakes and untidiness, the connected up instrument looks like a wiring diagram! The advantages to mass-production are very great.

Technical Development and Present Position of the Six-Wheeler (concluded). Describes with photographs and constructional drawings the Scammell six-wheeler, which, although it does not entirely fulfil the W.D. conditions, has been admitted to the ranks of the subsidized vehicles, on account of the extraordinarily successful way in which it accommodates itself to rough ground. There follow a photograph of the Thorneycroft 3-tonner with single-axle trailer, as extensively used in the Sudan, a photograph of the F.W.D. 6-wheeler, with all axles driven, and constructional drawings of the Vulcan 3-tonner.

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Finally, the last three W.D. conditions are discussed, viz. : (4) wide range of gears, in order to guarantee the necessary road speed, as well as the maximum tractive effect over bad ground ; (5) pneumatic tyres, and (6) the necessary stability against overturning, and the clearance requisite in front and rear for negotiating steep slopes, and beneath the lorry for clearing rough ground and crest tops.

Thoughts about the Tasks of Weapon-technics, by Lt.-Gen. Baron Botzheim. This article is written for the regimental officer, so avoids all purely technical and scientific questions. The author shows how all weapon construction is more or less of a compromise between the many factors of widely different nature which influence design. All these factors are in continuous development and change in value, as well as in mutual relationship. As an example of how differently the value of different factors has been estimated, he takes the German field gun, and shows how to the chief pre-war requirements, mobility and unified ammunition, had been sacrificed what turned out to be the chief requirements during the War, viz. : increased effect, increased range, and facility of mass production. Since an increase of calibre, which would have been the most rational way of meeting the first of these demands, could not be considered while war was in progress, there was nothing for it but to lengthen the projectile. The consequence was increased unsteadiness of flight, hence worse shooting, especially at longer ranges, the endangering of one's own infantry, and affecting their morale. Also the increase of range, which, except by improved shape of the projectile, was gained chiefly by lengthening the barrel and by increased charge, without, however, thorough ballistic trials, caused both greater dispersion, and too great a strain and consequent wear upon the gun. The necessary lengthening and strengthening of the carriages and recoil parts were prejudicial to mobility. The adoption of unified ammunition, too complicated for mass production, was a chief cause of the early shortage of ammunition at the front, and of the inferior ammunition which was hurriedly turned out to make good the deficiency.

The author then goes on to show that the post-war requirements of the German field gun further emphasize the range factor, in fact " range " has become a catchword, to which other requirements are being unduly subordinated.

He makes out a strong case for an increase of calibre above the present 7·5 cm., which he says is incapable of achieving effective action against small targets like artillery, m.g. nests, etc., at 10 kilometres ; while an accurately calculated barrage attempting to work on 25 and 50 metre differences of range is a chimera.—(*To be continued.*)

The Greatest Muzzle Velocity. This is a mathematical problem, not in ballistics, but in thermo-dynamics. A first attempt results in a figure, 1,165 metres a second, which is well below the muzzle velocity of the Bertha that bombarded Paris. This, according to the *Revue d'artillerie*, must have been 1,400 metres a second. Reality again vitiates theoretical results ; as it did when an officer in the Black Watch was so far lacking in filial respect as to drive a golf ball further than the distance worked out to be the greatest possible by his father, a professor at Edin-

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burgh University. The author's second attempt fortunately saves the situation by giving the answer as 1,630 metres a second.

"Gas over Germany," "Gas-protection," and *"The Air-danger and Air-protection possibilities in Germany."* These three pamphlets are a sign of the times. They mark the Paris Agreement's removal of the ban on passive air defence imposed on Germany by the Peace Treaty, and are of the nature of propaganda issued to enlighten the people as to their duties in the face of possible dangers. The first-mentioned pamphlet has already done duty once in this respect, as it is the translation of a Russian publication by the Osoaviachim or National League for the promotion of understanding of Air- and Chemical Warfare, the harrowing scenes and devastation being laid in Germany, so as to spare the Russian readers' feelings.

(*June*, 1928.)—*Theoretical Considerations on the Construction of Muzzle Brakes.* Calculations by a Hungarian engineer, which show the editor's high opinion of the German officer's mathematical powers and taste.

Starting, as last month's problem did, with the Adiabatic Law,

$$p_1 v_1^{k} = p_2 v_2^{k},$$

where $k = 1{\cdot}405$, or the proportion of specific heat under constant pressure to specific heat under constant volume, and with the velocity of the escaping gas as the base of the shell leaves the muzzle as :—

$$\sqrt{2g\frac{k}{k-1}p_1 v_1\left\{1-\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right\}}$$

the author, with the aid of Schüle's *Technical Thermo-dynamics* and Rausenberger's *Theory of Gun Recoil*, works through eleven pages of investigations into recoil without and with muzzle-brakes, and arrives at formulae to express the braking effect of the muzzle-brake and its efficiency. The stability question he appears to reserve.

French Instructions on the Organization of Terrain. Part II of the *Instruction provisoire sur l'organisation du terrain* deals with the design and execution of the works necessary for carrying out the principles laid down in Part I, and would make interesting and instructive reading for any R.E. officer already thoroughly acquainted with our own *M.E.* volumes. In this notice no review of the book itself is permissible, but those things in it will be pointed out, which particularly struck the German reviewer, either as dealing with points which have been omitted in the corresponding German manuals, or as showing divergencies between field engineering ideas and practice in France and Germany. As regards the design of ordinary fire-trenches, immediate exception is taken to the recommendation to provide loop-holes, for which the most varied types of construction are suggested, from wood and sandbags to gabions and iron, and to the statement that they considerably increase the protection of the firer, since the German experience is the contrary.

As regards the digging of fire-trenches, dismissed by the German manual in a few words, several pages are devoted to it, and go into every detail, the trace, issue of tools, marching up and lining out, intervals,

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disposal of earth, relays of spades, etc. It is characteristic of the French that according to the requirements of the work they form working-parties of different units (*ateliers*) instead of using the tactical units complete.

Very peculiar appears to the German reviewer that a second method of providing fire-trenches, viz., by the aid of the sap-roller, is not only mentioned, but described in detail. The single and double sap-rollers of the German 1906 manual are used, not for broadening the trench as formerly, but for deepening it, *i.e.*, for converting it from the standing fire-trench to the standing fire-trench improved.

The provision of shelters under the parapet is arranged for as follows: before the trench is started, the ceiling is laid out on the ground in position, first two wall-plates and then, resting on them and at right angles to them, a layer of joists (or *bullis*). The trench is then dug, and subsequently the shelter is made by digging out the earth under the roof. In the case of more solid dug-outs, the bursting-layers are made of 8" diameter round timbers, laid touching one another, and laced together with wire. For the bursting-layers of shelters in rear, small reinforced concrete slabs are used, with metal lugs in their rounded corners. When in position, these slabs are fastened together by stirrups of soft steel, which are tightened up with a special key. German war experience is against these slabs.

The reviewer commends the idea of connecting a dug-out with the open air by means of a boarded shoot, so that in case of the entrance becoming blocked, air and provisions can reach the entombed.

Diametrically opposed ideas are to be found as regards revetting. The French devote seven pages to the making of hurdles, fascines and gabions, while the German instructions announce surprisingly, "All revetting of trench walls is harmful." This dictum explains many a German trench!

As regards heavy machine-gun positions, the French order, and the Germans forbid, connections between the gun-positions, O.P., ordinary shelter, alarm shelter and the main trench system.

The emphasis of the necessity for making connected works is striking, thus "The advantages must always be stressed of works which are connected: they far outweigh the dangers which might arise from the easier discovery of those works by the enemy." Again, "One cannot strive enough against the inclination to content oneself with single shelters or with shelters for small numbers of men." Here the Germans take entirely opposite views.

In spite of the instructions covering 200 pages, they do not contain much of what is in H.Dv.276 Part II, and in H.Dv. 316, the corresponding German manuals. For instance, they omit tank-obstacles, the overcoming of obstacles, the putting of places into a state of defence, gas-protection of shelters, camouflage, dummy positions, water supply, the destruction of roads, etc. On the other hand, they contain in profuse detail much which the Germans take for granted, or which they have struck out as obsolete. Especially strange appears to the Germans the emphatic demand for the creation of internally-connected closed defensive posts.

The reviewer also criticizes the division of the instructions into Part

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I, description, and Part II, execution, since this leads to repetitions, swells the instructions, and makes them more difficult to use.

The Investigation of Materials by Röntgen Rays. Röntgen himself in 1897, two years after he discovered the Röntgen rays, examined a gun barrel by their aid, and pointed out how these rays might be utilized for proof purposes. It is, however, only recently that this use of them has begun to be developed. Apart from radio-activity, Röntgen rays originate from surfaces, glass or anode, under electronic bombardment, the greater part of the kinetic energy reappearing as heat, while a small portion becomes fluorescence, and re-radiation in a new form (the Röntgen rays) taking place in all directions from the bombarded surface.

For practical purposes the rays are produced in two kinds of tubes, ionic, exhausted to 10—4 mm. of mercury, or electronic, which are practically gas free, say, to 10—7 mm. of mercury of vacuum.

There are three methods of using the rays for proving materials, and they all require enormous voltages.

(1) The Absorption Method. This depends on the property of the rays of penetrating solid substances, but with partial absorption; thus defects, flaws and cracks can be discovered, since radiation is weakened at these spots in varying degree. Such weakening is observed either directly by projection on a screen, or by record on a photographic plate, owing to the property of the rays of reducing AgBr to Ag. Potential is necessary up to 200,000 volts to cause penetration of bronze to a thickness of 2", iron of 3", and aluminium of 1".

These thicknesses apply to photography only, considerably less being the maxima for observation by screen-projection.

(2) The Interference Method. This depends upon the property of Röntgen rays of being refracted when passing through crystalline substances. In this case flaws are discovered by variations, lines or spots, occurring among the circles characteristic of crystalline structures. Voltages are from 30 to 80 kv.

(3) Spectrum Analysis. As in the optical spectrum, so in the Röntgen spectrum, each element has its characteristic lines. Qualitative, and in favourable cases the quantitative, composition of the material can be determined. There is no question, at any rate at present, of this method supplanting chemical methods; but if not so accurate, it is certainly much quicker. Voltage required, up to 100 kv.

In general, the proving of materials by Röntgen rays is as yet undeveloped, but its further development will open up many new fields. Credit is due to the German Metallurgical Society for their pioneer work, for instituting lectures and for awakening widespread interest.

The German 1/50,000 *Map* (*the 2 cm. Map*). Most European countries have maps already of 1/25,000 and 1/100,000 or their equivalents; nevertheless, there is a general demand for a map on an intermediate scale. In France, a new 1/50,000 map has been decided upon, and is rapidly being produced. In Switzerland, the same. Long before the War, Germany had started with the issue of a 1/50,000 map of certain

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districts much frequented by tourists. Prussia had prepared such a map of Berlin and neighbourhood in 12 sheets. Bavaria had long since produced an atlas of 112 sheets of the same scale, and 55 such sheets had been produced by Würtemberg. Also, Saxony and Hesse had started on similar lines. Thus the idea gained ground that there should be a map of Germany at 1/50,000, and experimental sheets were got out. Finally, the Assistant Counsellor for Survey took the matter up, and had a sample prepared by his mapping committee in order to prevent maps of different appearance being produced by the different states, as was unfortunately the case with the 1/25,000 map.

The writer then gives the proposed details of the new map, with which he agrees except in the following particulars :—

(1) Maps are to be bounded by 12 minute parallels of latitude and by 20 minute meridians. He considers this makes them too small for military purposes, and recommends 15 minutes by 30 minutes.
(2) He thinks it a mistake to give the names of rivers and streams in blue, as insufficiently legible.
(3) For military purposes four conventional signs for bridges are required : up to 6 tons, up to 12 tons, up to 22 tons, over 22 tons.
(4) Kilometres should be marked on railways as well as on roads.
(5) He recommends stump-shading in addition to the contours.
(6) Heights of places, which stand out prominently, should be underlined or marked in heavier figures.

He approves of the introduction, on the margin, of scales of slopes, permitting one to transfer the distance apart of two contours, and for the appropriate V.I. to read off the slope in degrees. He hopes this may be extended to all other maps.

Thoughts about the Tasks of Weapon-Technics (*continued*). The theoretical solution of the problem would be to replace the 7·5 cm. field gun by a new field gun of calibre 8·35 to 8·5 cm. if horse-drawn, range 13 km., muzzle-energy 180 metre tons ; if mechanized, of calibre 8·8 to 9 cm., range 14 km., muzzle-energy 230 metre-tons. Practically, it is doubtful if any country, except possibly the U.S.A., would face the cost of a change of calibre of field gun, especially considering the large war stocks of guns and ammunition still in existence.

The post-war urgent demands for standardization to cheapen manufacture and to facilitate mass production led undoubtedly to real progress and to improvements, but also to not inconsiderable compromises and artificialities. Much time and labour were spent by constructors in all countries in trying to meet demands which the people who made them would, if they had been technically trained, have seen from the first to be incapable of complete solution. The reaction in this respect is now making itself felt in several countries. Experience has taught us, before making fresh demands on war-technics, to consult the technical experts and constructors and to allow them their say. They, on their part, must strive to seek out new ways and means of creating the technical principles for ever-increasing demands on weapon-technics.

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The present-day movements from which the weapons of the future will be developed are: the organization of air forces for independent action, including transport of troops and supplies (England, France, Italy, Poland, Czecho-Slovakia, etc.); mechanization, motorization and armouring of the means to battle (England, France and her vassal states); the laying out of prepared battle zones as boundary protection (France, Belgium and Poland); the organization, already in peace, of the protection of the population against air bombs and poison gas (Russia, Poland, and England).

The above movements are then discussed, and the author goes on to ask: With what means and forms of fighting shall we have to reckon in the more distant future, in five to ten years' time, and what are the tasks for weapon technics which will arise therefrom?

(*To be continued.*)

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REVUE DU GÉNIE MILITAIRE.

(*September*, 1928.)—There is a continuation of the article on the inundations on the Belgian front.

On November 3rd the bridgehead at Nieuport was reoccupied and the key to the complicated hydraulic system was again in Belgian hands. In December, 1914, a scheme was undertaken with the object of destroying all the crossings over the Yser Canal, which were in German hands. This was effected by opening all the ebb gates in the Ypres lock (situated at the end of the Yser Canal, where it joins the Channel of Nieuport), keeping the floodgates closed by means of ropes, and waiting for a low tide to obtain a large difference in level between the Yser and the Channel. The ropes were then cut and the floodgates opened, suddenly causing a violent current in the Yser, which carried away several foot-bridges.

At the same time, steps were taken to limit the extent of the inundation southwards, for water had naturally flooded all the land to the north-west of Dixmude. This was done by making a continuous bank from *borne* 16 on the left bank of the Yser to kilo 5 on the railway embankment, the area south of the bank being freed of water by means of the western ditches of the Furnes *watering*. The level of this inundation was regulated by manipulating the floodgates at the end of the Noordvaart Canal.

In August, 1915, severe damage was done to the Furnes and Ypres locks by German gunfire, causing anxiety for the weir of Noordvaart, on which the whole system of inundations depended. Its destruction would have left the flooded area at the mercy of the tides, the action of which might seriously have affected the security of the railway embankment, and this was the essential feature of the main Belgian position. So, to render this inundation independent of the Noordvaart weir, an auxiliary dike was made connecting the St. George dam on the Noordvaart Canal to some high ground on the north side and to the railway embankment on the other side. The construction of this dike was brought to a successful conclusion in three weeks under great difficulties. Work could only be carried out at night. The ground on which the dike was built was under water, whilst the sandbags used for its construction were filled on the west side of the railway embankment with waterlogged

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earth. It was called the Dumont dike after the name of the energetic subaltern who superintended its construction.

A problem which had to be faced was that of the drainage of the ground west of the railway, which was occupied by the Belgian Army. This land was drained in the first place by the Koolhof Canal, the siphon under the Furnes Canal and then through the lock on the old Furnes Canal (see plan in December number of *Royal Engineers Journal*), since the bridge opening over the Veurne Ambacht had been closed since December. But the flow in the old Furnes Canal was very slight, and in winter and during heavy rain was insufficient. Evacuation of water was therefore arranged through the Loo Canal, either by the sluices connecting direct with the canals or ditches, or by powerful steam pumps installed at the Slopgat and at the Beverdyck. Water passed from the Loo Canal to the Furnes-Nieuport Canal, and found the sea through the Furnes lock and weir. But after the destruction of the latter in 1915, water was passed to the sea through the Oostvaart lock and the Noordvaart weir, the St. George barrage being kept shut. This operation was facilitated by the existence of the Dumont dike, which isolated the Noordvaart inundation.

The Loo and Furnes Canals, primarily for navigation, were thus used for drainage purposes. In times of flood considerable trouble was experienced in the evacuation of drainage water from the occupied area, and in maintaining traffic on the canals. The Furnes-Dunkirk Canal, however, could be kept at its normal level by closing the Nieuport lock at Furnes, whereby it could be isolated from the other two and navigation along it, which was always particularly active, maintained. To insure the complete drainage of the land it was essential that all ditches should be kept free of obstruction. For this purpose a "special service of waterings" was entrusted to the *génie*. Its duty was to watch the currents and to dry up the land. A system of gauges at all critical points was established. In spite of all precautions, the army suffered cruelly from the continual struggle against the waters.

* * * * *

In November, 1914, after the capture of Dixmude by the Germans and the retreat of the 89th French Territorial Division on the left bank of the Yser and the Yperlée Canal, it was decided to inundate the land south of Dixmude as far as Knocke. The left bank of the Yser is embanked south of Dixmude, whilst the right bank is low from *borne* 21·5 southwards, and this admitted of all ground to the east of that part of the Yser being flooded by the admission of sea water. The limits of this inundation were, therefore: the right bank from Dixmude to *borne* 21·5, thence the left bank as far as Knocke, the Knocke dam and the road Knocke-Driegrachten up to a point at level 4·30. The Knocke dam, consisting of sandbags laid between the piers and abutments of the bridge, was constructed by the French Army. This inundation was regulated by the Ypres lock and its weir; it was called the inundation of Blankaart, after a pond in that area. It was kept at level 4·00 so as not to flood the trenches in the bridgehead immediately south of Dixmude. But the waters of the Yser equally affected the Handzaeme Canal, which overflowed and caused a further inundation north of the town.

The construction of the Knocke dam left no outlet for the upper waters

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of the Yser. The overflow was evacuated by the weir of Fintelle, the canals of Loo and Furnes-Nieuport, and the Furnes lock and weir, and, after the destruction of the latter, by the Oostvaart lock and the Noordvaart. But in heavy floods the Dunkirk Canal had to be used as well, and navigation on all the canals had to be stopped.

In order to make the inundation of Blankaart independent of the Ypres lock, the destruction of which would have left the ground south of Dixmude at the mercy of the tides, a sandbag weir with its lip at level 4·00, was constructed at *borne* 21·500.

* * * * *

At the beginning of 1915, the French Army considered it necessary to make an inundation upstream of Knocke. An attempt was made to introduce sea water through the Furnes lock and by the canals of Nieuport-Furnes and Loo, but the result was not satisfactory.

Pumps were, therefore, installed at Fintelle for pumping water from the Loo Canal; normally this was not necessary, as a flooded area could be formed by stopping the evacuation of surplus water from the upper Yser. But in summer, owing to the loss of water through evaporation, pumping was always required. This inundation, the desirable level of which was fixed at 4·30, was most capricious, there was always too much water in winter and not enough in summer.

* * * * *

These two inundated areas above Dixmude were very interesting, not only because they protected an important part of the front, but because they acted as a reserve for the inundation of Noordvaart. In May, 1915, a breach was made in the left bank of the Yser at *borne* 15·700 in order to connect the Yser with that area, so that the waters of the two upper inundations, the levels of which were 4·30 and 4·00, could be utilized to supplement the lower one, the level of which was 3·20.

* * * * *

When Lombartzyde was reoccupied by the French, who were defending Nieuport at that time, various measures were taken by them. The creek of Nieuwendamme, which was entirely inundated, was drained at low tide by means of the weir of the Old Yser. Then, to protect the trenches made by them in that area, they made a breach in the north bank of the Yser and effected an inundation through the weir of the Ypres lock. This they called the "inundation of the Polder." Owing to the existence of the bridgehead, it was impossible to use the Nieuw-Bedelf Canal for obtaining sea-water, as the whole area of the bridgehead would have been submerged.

By preventing the evacuation of water from the ground in German occupation, that area would become automatically inundated. To this end, the French troops constructed a sandbag barrage at the Nieuw-Bedelf bridge, called the "pont de Pierre," thereby causing an inundation called "Groot Bamburg." This was increased by draining sea-water from the Plasschendaele Canal through a breach made upstream of the bridge in the north bank of the Canal, water being admitted at every high tide by the lock "du Comte" at the end of the canal. The Germans retaliated by opening a connecting lock between the Plasschendaele Canal, and a branch of the Old Yser, sending back into the Old Yser and the French trenches water intended for themselves. It was,

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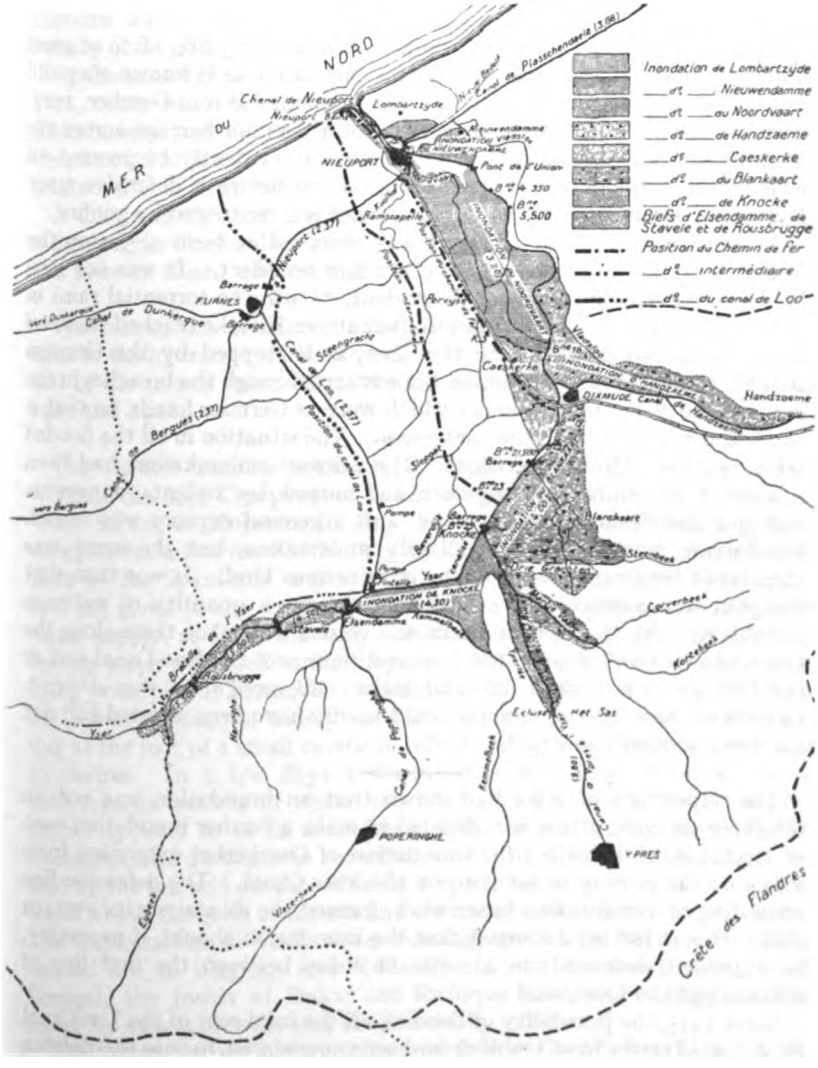
therefore, necessary at every low tide to evacuate by the weir on the Old Yser a large part of the water admitted at high tide into the Plasschendaele Canal. This plan was soon abandoned.

In May, 1917, the French troops were relieved by British, who had

Revue du Génie militaire Tome LXIII Inondations de la région de l'Yser en 1918



Major Deguent, Les inondations du Front belge 1914–18.

difficulty in preserving the bridgehead. German artillery destroyed the weir of Nieuw-Bedelf, and the sluices of the lock " du Comte," which left the whole area of the bridgehead at the mercy of the tides. Attempts were made during two months to repair the damage, but without success. This is a rare example of an inundation caused by gunfire.

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In 1918, the Belgians again took over the Nieuport sector. The general defensive imposed on the Allies during the first six months of the year led to the extension of the area of inundation north of Nieuport. Breaches were made in the north bank of the Channel of Nieuport and in the Lombartzyde road to allow sea water to cover the whole of that area.

* * * * *

Up to 1917 the Germans had retaliated by artillery fire, often of great violence, to these hydraulic operations, but as far as is known they did not undertake any special works to oppose them. But in October, 1917, aerial photos revealed the construction of a German barrage across the Yser at *borne* 4·350, the object of which was evidently to prevent all evacuation through the Ypres lock so as to insure a defensive front between Dixmude and Ypres. This barrier was destroyed by gunfire.

In January, 1918, a new barrier was observed at *borne* 5·500 on the Yser Canal, but this time artillery fire had no effect. It was not long before unpleasant results became evident. Owing to torrential rains in the early months of 1918 the inundation above Knocke reached the level 4·80; water overflowing into the Yser, and, stopped by the German barrier, swelled the inundation of Noordvaart through the breaches in the bank of the Yser and by sluices which were in German hands, so that it reached the level of 3·70 (normal 3·20). The situation in all the flooded areas became extremely critical. The railway embankment had been weakened by numerous dug-outs, and mined by rodents, dangerous leakages and fissures had occurred, and a general rupture was feared. Reinforcing works were immediately undertaken, but the army was threatened by a catastrophe of the most serious kind. It was then that the plan was conceived of evacuating as large a quantity of water as possible through the locks at Dunkirk. Water was taken there along the Loo and Dunkirk Canals: the powerful pumps of the Loo Canal and at the Fintelle lock worked day and night; all navigation was stopped. In spite of these efforts, disaster could hardly have been averted had not the rains suddenly stopped.

The experience of Riga had shown that an inundation was not an infallible obstacle, and it was decided to make a further inundation west of Dixmude, to be called the inundation of Caeskerke, extending from kilo 5 on the railway to *borne* 19 on the Yser Canal. The defensive line consisting of a continuous breastwork, formed the dike along its western side. It was further arranged that the inundation should, if necessary, be extended westwards in a series of zones between the first line of defence and the Loo Canal.

Since 1915, the possibility of flooding all the land east of the Loo Canal by means of water from Dunkirk had been considered, in case the Belgian Army should be forced to retire on that line, for water from the inundation of Noordvaart would not have sufficed for that purpose. To enfurther this scheme two dams were constructed:

(1) Across the Furnes-Nieuport Canal near Furnes to prevent waters sent from Dunkirk being evacuated at Nieuport by the enemy.
(2) Across the Bergues Canal near Furnes to prevent the area occupied by the Army being submerged.

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Each dam had a navigable by-pass. These works were satisfactorily completed during the first six months of 1918.

Water sent from Dunkirk at high tides by the Dunkirk and Loo Canals could be spilt through the locks of the principal canals of the Furnes *watering*: Steengracht, Slopgat, Beverdyck and finally by breaches to be made in the eastern bank. But in order to insure the availability of Dunkirk water, even at low tides, the English Army installed there a battery of six pumps under concrete protection.

At the same time, in order to strengthen the position along the Upper Yser, dams with weirs were constructed across it at the bridges of Elsendamme, Stavele and Rousbrugge, whereby three inundated areas were formed at levels 4·50, 5·00 and 5·50. A serious obstacle was thus created, which, however, was never required to play a part in the defence.

A dike was also constructed north of the Furnes-Dunkirk Canal to safeguard the Furnes-Dunkirk railway and the littoral region; this dike was later on raised and extended into French territory.

* * * * *

The rest of the article contains an account of the principal injuries done to the hydraulic works, and the measures taken to counteract them, and of the means taken to reduce the inundations for the offensives of 1917 and 1918.

The *October* number contains an article by Colonel Sergent on the work of the 26/2 Company of Génie at Mahédia, at the mouth of the Wadi Sebou, in Morocco, in May, 1911. This place, which had been occupied for a few months in 1515 by the Portuguese, and from 1614 to 1681 by the Spaniards, was selected as a secondary supply base. The first job given to the company commander was to provide an adequate water supply, as there was only one well in the place. The prospect of finding water appeared to him hopeless till he recollected certain encouraging principles of Paramelle contained in his book, *The Art of Discovering Springs*, which is widely used in Algeria. A well was accordingly dug at the foot of a small ravine in which water was found at a depth of 2½ metres. In a few days a dozen wells were dug, showing that a subterranean surface of water had been struck. The existence of this supply appears to be in accordance with the instruction given at the Ecole Militaire du Génie to the effect that: "in a massif bounded on one side by the sea and on the other by a river, there often exists a sheet of water above the level of the sea and the river, and inclined towards both. The exploitation of such water-bearing strata has been successfully carried out in Belgium and Holland. In our colonial possessions of Senegal, the towns of Dakar and Rufisque have been so supplied, the latter by means of wells and the former by galleries."

The November number contains an article by Chef de bataillon J. L. R. Faure on the construction of the railway connecting Thiès near Dakar in Senegal to Kayes on the Senegal River in French Soudan, a distance of 667 kilos.

An article entitled "Inundations in Orania," by Chef de bataillon Mauboussin, describes the repairs carried out by the sappers in Algeria following on the damage caused by the heavy rains in November and December, 1927, and January, 1928. The areas which suffered were the

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region Orléansville-Tenès traversed by the Wadi Allala, the region Mostaganem in the valley of the Wadi Ain Sefra, and in the region drained by the Wadi Saida and its tributaries, which reach the sea at La Macta. Roads, bridges, pipe lines and embankments were swept away, and a large reservoir was breached.

A.H.B.

REVUE MILITAIRE FRANÇAISE.

(*October*, 1928.)—Commandant d'Argenlieu finished "*La bataille de l'Avre*" in this number. The instalment gives first a short description of the action of the German troops, and then draws certain conclusions. The writer admits frankly that the German troops, trained in Russia, ran rings round the French at first, but he points out how quickly the French took to the new open warfare, and how their final success was reflected in letters captured from prisoners. The conclusions are familiar to us: the will to win, as exemplified particularly by General Débéney, and the problem of organization of staffs during the confusion of units always produced in defensive operations of this sort.

The fourth instalment of Colonel Bailles' "*Franchissement des fleuves en présence de l'ennemi*" appears in this number. The Austro-German attempt to cross the Piave in June, 1918, is the example selected, and a detailed description of the preparatory measures is given. The extreme difficulties of the operation are clearly pointed out, and a good bird's-eye view of the Montello, on the front of attack, illustrates the instalment.

"*Le général Brialmont*," by Lieutenant-Colonel Mayer, is really a review of the biography of Brialmont, the designer of the fortress of Antwerp. Brialmont died in 1908, and his niece has brought out this excellent little biography. The General was evidently a better engineer than strategist, but his views on the design of fortresses were eminently sound. He was brought up to use the gun and fishing rod, rather than the pen; but once he began to study for the Army he combined writing with his military duties from the start. He was a great opponent of the idea of a large number of small fortresses, which held the field seventy years ago, and he was really responsible for introducing the defended camp, such as was Antwerp at the outbreak of the Great War.

In continuing "*De L'ancien au nouveau règlement du Service de Santé*," Médecin Général Uzac describes the different medical echelons from front to rear, with illustrations from different operations of the Great War and the War in Morocco. The most interesting example given was the evacuation of wounded from advanced landing grounds in Morocco by aeroplane. There is no doubt that aircraft will become of more and more importance for this work in uncivilized countries.

"*L'opération effectuée sur Bou-Ganous le 25 septembre 1925*," by Colonel Gondot, describes a minor operation carried out with complete success in Morocco. The reasons for the success were mainly detailed reconnaissance, both by air and on the ground, the provision of troops solely for mopping up, and the actual energy and drive of the troops employed. Although four sketches are given, the detail on them is insufficient, and the article is written in a rather dull form; but as an example of a minor operation of this kind it is well worth studying.

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(*November*, 1928).—"*Comment mettre sur pied une monographie de combat*," by Colonel Grasset, is an interesting little article by this well-known French military writer. Three main questions are considered: the writer, his materials, and the time available. Colonel Grasset points out how difficult it is for a writer to guard against bias; he then discusses the various orders, reports and *questionnaires* from which the article must be drawn up, and finally he points out what a long time is necessary before the writer can be finally sure that his monograph is really correct. Colonel Grasset's well-known books on Ethe, Virton, etc., took from five years upwards to complete, and there is no doubt that he was successful in "delivering the goods" in these monographs. This article is of real value to anyone who proposes to write monographs of this type.

In the third instalment of Médecin Général Uzac's "*De L'ancien au nouveau règlement du Service de Santé*," some of the lessons of 1918 are discussed. The writer points out that, although the present French organization is based on the experiences of this particular year, it must be realized that the next war will probably be a war of areas, rather than lines, and consequently highly mobile ambulance formations may be required. The inefficiency of the French ambulance trains, compared to ours and the Americans', during the Great War, is alluded to; and the writer points with approval to the new system of earmarking possible hospitals in various regions in the event of war.

"*L'ajustage des feux et la manœuvre*," by Général de St. Maurice, is a discussion of the axiom that an advance is carried out by fire and movement. The tendency during the Great War was for the infantry to walk forward protected by an overwhelming artillery fire, but the writer points out that the infantry should also do its part. Artillery fire is bound to be partially blind, and the infantry should normally be in a position to fill in the gaps in the fire of the artillery. This instalment is rather spoilt by being written in a form which does not make the salient points very clear, and there is a superabundance of italics.

Commandant Oudet, in "*Sur les méthodes d'étude des nouveaux matériels de guerre*," discusses the disappearance of the old régime, when most war material was made in State arsenals, and gives his views as to requirements for the future. Invention is now progressing at such a pace that it is useless to turn out a vast number of (say) tanks now, as they will probably be obsolete when war comes. A sharp division is therefore necessary between experimental and mass construction. While State factories will continue experimental work, it will probably, in the future, be the duty of private firms to undertake general construction. The article is an interesting discussion of what is really the mobilization of industry for the next Great War.

Colonel Bailly completes "*Franchissement des fleuves en présence de l'ennemi. La bataille de Montello.*" He describes briefly the passage of the Piave by the Austrians and their retreat a few days later. The technical reasons for the failure were the lack of training of the Austrian engineers and the failure to provide a sufficient reserve, but it must be realized that the front of the attempt to cross was too narrow, so that Italian guns were able to converge on the short successful crossing, and so prevent a further advance. The flanks of an effort of this kind

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are bound to be the most vulnerable part of the movement, and so a tremendous artillery and air superiority is required by the attackers. The writer concludes by pointing out that the percentage of successes in river crossings has decreased considerably during the Great War, and he asks for the further training necessary to establish the confidence required between the engineers and the attacking troops.

(*December*, 1928.)—Capitaine Minart begins "*La division Exelmans le 28 août* 1928" in this number. General de Laurezac's V Army was retreating, and he had already fallen out with the British Commander-in-Chief. Apparently General Exelmans, in the centre of the V Army, received a report that the IV Army was engaged in a decisive struggle on the Meuse, and also that part of the German forces had veered off to the west. This induced him to turn on them. This instalment describes the arrival of the leading German troops in Guise, on the front of the V Army.

Général de St. Maurice completes "*L'ajustage des feux de la manœuvre*" He begins by an example from his own division, the 37th African, which took part in the great attack of 8th August, 1918. Here he shows how, after a successful attack, the lack of a mobile machine-gun unit prevented the utter rout of the enemy, and again, how the enemy were allowed to re-form because the infantry were awaiting artillery fire instead of carrying on with their own weapons. The article is concluded by the forecast of small tanks, or similar vehicles, for battalion and regimental commanders, so that they can get about more easily to co-ordinate the fire of the infantry, and also by the opinion that more wireless will be required to improve the liaison between the infantry and the artillery. This liaison question has always been one of the biggest problems of modern war, and it seems that the designer of wireless instruments for forward use has to improve his sets considerably yet before they can be depended on in the forward area.

Lieutenant Kersnowski's "*Une mise au point*" is a Russian's opinion of the German successes in East Prussia of 1914. While admitting the value of Ludendorff's direction of the different battles, Lieutenant Kersnowski points out how General Hoffman had already prepared plans for the Battle of Tannenberg before Hindenburg and Ludendorff took over command. He also explains that the German claims of prisoners are grossly exaggerated. To us, who have had an impartial account of the battles from Sir Edmund Ironside, the article is not of particular interest.

Capitaine Perré has a sensible article entitled "*La protection des chars dans la bataille*" in this number. He points out that the commanders of tank formations are apt to call for an excess of protection, whereas they are really in the same situation as commanders of other formations until they actually attack. All troops require protection while on the move, but in the attack tanks are specially vulnerable to the anti-tank gun. This is where the infantry becomes particularly valuable. The tank provides protection against the enemy's infantry and machine-guns; the infantry provides protection against the enemy's guns at point blank ranges. It is only by close co-operation between tanks and infantry that both arms can act to their fullest efficiency.

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Colonel Grasset begins "*Montdidier, le 8 août, à la 42e division*" in this number. The instalment is devoted to a most graphic description of the preparations for the great attack, and of the special measures taken to camouflage these preparations. The camouflage was so successful that the front line troops had no idea of what was impending, which was just as well owing to a successful German raid before the attack. Colonel Grasset has the knack of making the salient points stand out from a mass of detail, and this instalment gives a very good idea of the enormous amount of work required before a trench warfare attack can be launched.

H.A.J.P.

CORRESPONDENCE.

RAILWAY DEMOLITIONS.

Railway Training Centre, R.E.
Longmoor Camp,
Hants.
5th December, 1928.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

Referring to Lieut.-Colonel E. P. Anderson's letter in the *R.E. Journal* for December, 1928. It is fully realized that guncotton slabs *under* the rail are more effective than at the side of the rail in track demolitions, and this is advocated at the Railway Training Centre, R.E. Vertical cutting was forbidden in this case, however, because of the risk of casualties from flying pieces of rail to the raiders themselves, and to a thickly populated camp near by. Horizontal cutting was, therefore, arranged, so that all pieces flew horizontally away from the Camp, and away from the raiders themselves. This fact should perhaps have been made clearer in the article.

The rail and bridge demolition was described as actually carried out. At a later date, other pile and trestle legs (soft wood) were destroyed by auger holes filled with primers, necklaces, and guncotton slabs in various arrangements and quantities. As stated by Colonel Anderson, five or six primers in an auger hole was certainly the most effective method of all. The 12 x 12 timber was split longitudinally for some five to six feet each side of the actual cut, and set on fire in two cases. The bridge gap was, of course, a dry one, there was a high wind, and the whole bridge would probably have been gutted as a result of the fires which started in two splintered legs. Necklaces were useless. The five primers applied internally were more effective than three guncotton slabs applied externally.

Yours faithfully,
I. SIMSON, *Major, R.E.*

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RATIONAL MECHANICS.

The Editor, *The Royal Engineers Journal.*

SIR,

I have to thank you for the review of my little book, which is certainly very flattering—and (I hope) deserving of it.

The reviewer says some of my criticism is " captious " ; I hope that in this he is mistaken : I tried my best not to attack simply for the sake of attacking ; when necessary, however (having specialized on Hydromechanics for nearly 40 years, and having studied how *real* fluids actually *do move*), I have not been afraid to attack ; and as your reviewer further says, I am " no respecter of persons or theories," meaning by this, that I grovel before no man's *opinion*, though I hope I " respect " those I attack. In fact, if I did not, I would not attack their views. He will, I feel sure, do me the credit of admitting that I never attack any small man. If a writer has arms on his shield, and wears gold spurs, he is a knight worthy to break a lance with.

As to " theories," I have not hesitated to call the almost sacrosanct, Kinetic Theory of Gases (that happy hunting-ground of the mathematicians) a " wild-cat theory " ; since such an imaginary medium *could not vibrate.* The Professor to whom I said this lately, replied that he " saw no reason why it should not vibrate." I, also, see no *reason* why pigs should not fly. I know they do not ; and I think I am justified in saying that no animal built on these lines *could* fly. He would not have *de quoi.*

Your reviewer makes a slip when he says I " endow " liquids and gases with rigidity. I endow them (and solids too) with *viscosity.* Rigidity (as I think the term should be used) is *not a property.* It is nothing more than *the measure of the intensity* of the resistance to change of shape. To speak of rigidity (in the proper *mechanical* sense), without reference to time, is, in my mind, meaningless. The rigidity of water, *in unit time*, is negligible. In one-thousandth of a second it is *very large.* Similarly, the rigidity of ether in 10^{-15} of a second is *colossal.*

My views (right or wrong) were derived from P. G. Tait's *Properties of Matter ;* at page 290, para. 316, he says, " The dimensions of viscosity therefore differ from those of rigidity simply by the time unit ; *i.e.*, as the dimensions of velocity differ from those of acceleration."

This I read as, $\text{Rigidity} = \frac{\text{Viscosity}}{\text{Time}}$. If your reviewer can give me any better and simpler view, I shall be delighted to accept it. It must explain, of course, why one cannot cut a very rapidly flowing jet of water with an axe. How water can dent in the armour-plates of a battleship. How a rapidly rotating closed chain can hop along the floor like the wheel of a bicycle, etc., etc.

To call this " pseudo-rigidity " *means* nothing. As well call it " pure cussedness."

That the reviewer was disappointed with my chapter on " relativity " was unavoidable. I know nothing of metaphysics ; nor can I understand a theory of " relativity " which is *based on an absolute*—whatever " absolute " may mean. I consider Einstein's theory a very beautiful

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mathematical fairy tale, told in very beautiful (as far as I can follow it) mathematical poetry. I should call it (with apologies to Dante) "the mathematical comedy." My views on it might be expressed by a quotation from Epictetus.

'If you will consider this with me, I shall say, first, that you must attend to the sense of words.

"—— so, I do not understand them?"

You do not.

"—— How then, do I use them?"

As the unlettered use written words, or as cattle use appearances; for the use is one thing, and understanding another.'

R. DE VILLAMIL.

December 12th, 1928.

MOTHER SHIPTON'S PROPHECY.

IT may be of interest to read the words of an old English wise woman, uttered about 1530 near Knaresborough, Yorks, and to notice what parts have come true, and the possibility, or otherwise, attached to those which have not yet been obviously verified.

Over a wild and stormy sea
Shall a noble* sail,
Who to find, will not fail,
A new and fair countree,
From whence he shall bring
A herbe† and a root‡
That all men shall suit,
And please both ploughman and king;
And let them take no more than measure,
Both shall have even pleasure
In the belly and in the brain.
Carriages without horses shall go,
And accidents fill the world with woe.
Primrose Hill in London shall be
And in its centre a Bishop's see.
Around the world thoughts shall fly
In the twinkling of an eye.
Waters shall yet more wonders do,
How strange, yet shall be true,
The world upside down shall be,
And gold found at the root of a tree.
Through hills shall men ride
And no horse or ass be by their side.
Under water shall men walk,
Shall ride, shall sleep and talk;
In the air men shall be seen,
In white, in black and in green.
A great man shall come and go—

* Sir Walter Raleigh. † Tobacco. ‡ Potato.

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Three times shall lovely France
Be led to play a bloody dance ;
Before her people shall be free
Three tyrant rulers shall she see,
Three times the people's hope is gone,
Three Rulers in succession see,
Each springing from a different dynasty,
Then shall the worser fight be done
England and France shall be as one.
The British olive next shall twine
In marriage with the German vine.
Men shall walk over rivers and under rivers,
Iron in the water shall float,
As easy as a wooden boat :
Gold shall be found and found,
In a land that's not now known.
Fire and water shall more wonders do.
England shall at last admit a Jew ;
The Jew that was held in scorn
Shall of a Christian be born and born.
A house of glass shall come to pass
In England, but alas !
War will follow with the work,
In the land of the Pagan and Turk,
And State and State in fierce strife
Will seek each other's life.
But when the North shall divide the South
An eagle shall build in the lion's mouth.
Taxes for blood and for war
Shall come to every door.
All England's sons that plough the land
Shall be seen, book in hand.
Learning shall so ebb and flow,
The poor shall most learning know.
Waters shall flow where corn shall grow,
Corn shall grow where waters doth flow.
Houses shall appear in the vales below ;
And covered by hail and snow,
The world then to an end shall come
In Nineteen Hundred and Ninety One.

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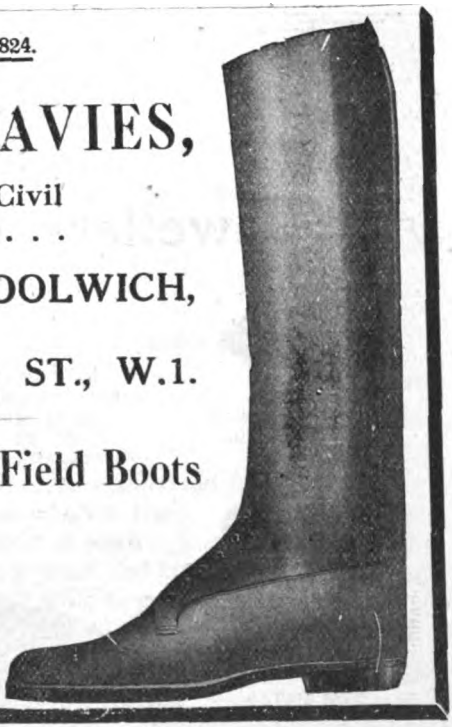

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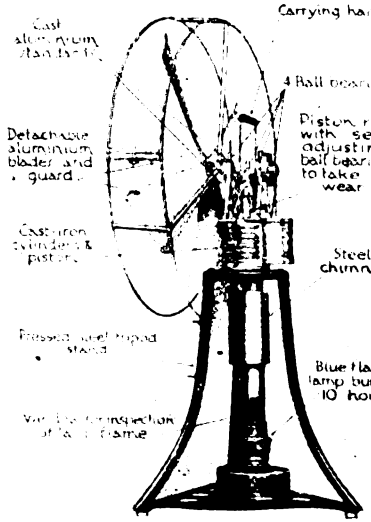
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THE subject is so large and complex that it is only possible, in a single lecture of an hour's duration, to deal with it in part, very generally and very briefly.

Many, varied, and intricate, are the peace time problems which arise in railway management, construction and operation; and war introduces additional complications.

It is not my intention to discuss civil railway organization or to refer in any detail to the everyday engineering and operating problems which arise both in peace and in war—time would not permit. My remarks must be mainly confined to a few of the special problems which war introduces.

I purpose, therefore:

Firstly, to consider some of the main differences between peace and war conditions and working, and the special problems arising therefrom, which confront the railwayman in war, and which are met with in the handling of the requirements of an army in the field.

Secondly, to deduce some of the lessons of war railway history, and,

Thirdly, to glance at our military railway organization to see to what extent the special conditions of war have been provided for.

Before proceeding to the first of our considerations, the problems arising out of the fundamental differences between civil and military railway conditions, let us get an idea of the extent of the railway problem in war.

I read a paper the other day, in which the writer, having reviewed the increasingly important part played by railways in the wars of the last hundred years, arrived at the conclusion that to all intents and purposes railways won the Great War. I believe the author was a railwayman.

It is nevertheless a fact that efficient transportation is absolutely vital to a modern army.

In this connection it is a matter of interest that it was represented

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by Brig.-Gen. H. O. Mance in 1916, when the advance into Palestine was under consideration, that we must have overwhelming rail power, *i.e.*, sufficient to maintain the necessary margin of troops over a possible Turkish army and on the more elaborate scale necessary for our troops. As a result, it was decided that a standard gauge railway with a minimum grade of 1/100 was essential. As the campaign advanced, it was found that our single line had to handle up to 24 trains a day in each direction, which was cutting the capacity too fine, and, therefore, the doubling of the line, which had been started in 1917, was continued as far as the junction with the Beersheba line, before the final attack.

I think it may be said without fear of contradiction that victory in civilized warfare may well rest with the army with full freedom and power of movement, strategical, tactical, administrative, *i.e.*, with the army with the best and most efficient transportation services.

I have used the word transportation, and not railways, because it is necessary, particularly for the British Empire with its scattered territories and practically world-wide interests, to realize that the problem of movement in war involves every kind of transportation, by sea, by rail, by inland water transport, by road, and by air.

In any war in which the B.E.F. takes part, the transportation chain will consist of a number of links, of which, in the theatre of war itself, railways may be the most important.

I have deviated somewhat from the subject of my lecture, but it is necessary always to keep in view that railways are a part of a larger service—transportation.

Now to return to the railway problem itself in the theatre of war:

Firstly, railway construction, both new work and repair, will be necessary.

Secondly, railway operation, with the subsidiary services of rolling stock repairs, stores, statistics, etc., will have to be undertaken.

Thirdly, it may be required to transport guns on special railway mountings and to construct and work armoured trains. The heavier guns may be fought from specially-constructed sidings, whilst armoured trains may be in action at any threatened point of the railway system.

The abnormal conditions which war produces will invariably necessitate some modification of normal civil practice in organization, in construction and in operation, as will become apparent later.

Great as has been the part which railways have played in the wars of the last three-quarters of a century, it is not an exaggeration to say that an efficient railway system and service are becoming more and more essential to the success of a modern army in civilized warfare.

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The increase of, and improvement of, mechanical transport and the progress of mechanization, whilst increasing the power of manœuvre, are not likely to oust the railway in any way and do not relieve it, but rather impose additional burdens.

The railway must now be able to carry this transport, to load and off-load it with ease and rapidity, to provide it with its petrol, oil and spare parts, whilst its very mobility will tend to more rapid advance and, therefore, to the necessity of more rapid railway construction. In addition, the impedimenta of a modern army is vastly in excess of what it used to be.

Except in a European war, a parallel rail and road service is unlikely on the main L.-of-C. in a theatre of war, more especially where it is a long L.-of-C. On the other hand, the heavy tonnage to be carried will fix a more or less arbitrary boundary, at railhead, between rail and road transport; and, in most theatres of war, the construction and maintenance of the roads will present such a vast problem, as to result in invariably requiring the railway to carry the maximum and to put the minimum on to the roads.

I think I have said enough to show that there is no rail versus road competition, in war, at all events, but rather that they are entirely complementary.

I have stressed this, because one hears so much of road versus rail competition nowadays, in order to emphasize that "railways in war" is not a problem of less magnitude than in the past.

Now for some of the chief technical differences between practice on a civil railway, in peace, and that on a military railway, in war.

Firstly, as regards construction :—

In peace, ample time is taken to ascertain that the best route is adopted to obtain and carry the maximum traffic at minimum cost.

In war, rapidity of construction is all-important, consistent with a route of sufficient capacity.

In peace, designs of all works must be got out in detail and the cost be estimated.

In war, lack of time will seldom admit of working out and comparing designs in detail.

In peace, temporary work is kept to a minimum, and permanent work, once sanctioned, is put in hand.

In war, the proportion of temporary and semi-permanent work will be comparatively high, owing to the necessity for working traffic through as early as possible. Temporary bridge work is likely to be a feature of railway construction in war.

In peace, financial sanction from headquarters is necessary before any but very trivial new work can be begun.

In war, executive officers must be prepared to take responsibility in starting necessary new works.

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On civil railways, heavy earthwork is undertaken to avoid steep grades and sharp curves and the consequent limitations they impose; and large works, such as deep cuttings, high embankments and tunnels, are justified to shorten the line, to increase the train-load and otherwise to improve and to cheapen the working conditions.

On a war railway, rapid construction and, consequently, the avoidance of heavy earthwork, are of primary importance. Reduction of the ruling grade to a minimum must be obtained by lengthening the route, rather than by undertaking heavy construction work.

A civil line must be sufficiently heavy for the rolling-stock, and must be well ballasted and constructed to a high standard generally.

In war, the standard of permanent way need only be sufficient to stand the comparatively slow traffic for a few years. Ballast may not be available, or the line may be only very poorly ballasted, unless ballast is found alongside.

In peace, expenditure is justifiable on good permanent soft-water supplies.

In war, an ample supply of water is all-important, but permanent installations take time; and water-tank wagons and water trains may become a necessity in more or less waterless regions.

Secondly, as regards operation:—

On the civil railway, policy is principally determined by financial considerations; and the granting of reasonable facilities to all traders without discrimination is a fundamental principle of commercial railway operation.

On the military railway, commercial requirements give place to military requirements, which will strictly determine the priority of traffic.

The volume of traffic can be estimated with reasonable accuracy in advance on a civil railway, and the line be economically equipped to meet it.

In war, the volume of traffic may undergo sudden and unforeseen changes. The capacity of the railway will certainly be strained to the utmost, at times, if not continuously, and may fall short of full requirements.

On a civil railway, comfort of passengers and care of goods must be given first consideration.

On a military railway, the prior consideration is often to carry the greatest possible number of troops, provided they do not suffer excessive exposure, and the maximum tonnage of supplies and stores irrespective of risk.

In civil railway working, truck-loads and train-loads vary according to traffic requirements;

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whereas it is an axiom of railway operation in war, to work as heavy trains as possible, composed of high capacity wagons, loaded to the full and hauled by powerful locomotives—full truck-loads and full train-loads.

Trains on a civil railway are run at varying speeds to suit the convenience of traders and of the travelling public.

In war, timings are more uniform, thus admitting of a maximum tonnage on fewer and heavier trains at comparatively slow speeds, which are to be preferred to a greater number of fast trains more lightly loaded.

Breakdowns due to accident or exceptional weather conditions are rare on the civil railway :

whereas the military railway is liable to interruption by hostile aircraft, long-range shelling, raids, sabotage, armoured trains in action. Suspension of night running may be necessitated, particularly in the forward areas. On the other hand, it is conceivable that night running might be preferred to daylight working if the enemy were superior in the air.

The technical operating personnel on a civil railway is thoroughly trained and organized, generally well disciplined and accustomed through long service to a routine of work.

In war, work will not be of such a routine nature, exceptional conditions will be met with, and railway personnel will, at times, have to work for very long hours at a stretch. In addition to the railway troops, it may be necessary to employ hastily-collected personnel, only partially trained. Operating may not be as efficient, therefore—an additional reason for fewer and, therefore, heavier trains.

In peace, it may be generally assumed that locomotives and rolling-stock are sufficient to meet demands, that they are designed to suit the nature of the traffic and the curves and gradients of the route, that a regular programme of repair and replacement is practicable and that a high standard of efficiency is maintained. Multiplication of types is avoided as far as possible and standardization and interchangeability of parts are aimed at.

On a military railway, locomotives and rolling-stock will probably be scarce and, in an endeavour to increase numbers, a diversity of types will be introduced. All this complicates the questions of repairs and spare parts. Engines and rolling-stock will be retained in service after they should have been turned over to shops, and margins of safety will be reduced below normal standards.

In civil practice, electric block instruments and interlocked signalling are considered essential for safe and expeditious train working.

In war, whilst these would continue to be used, if available and in good order, on existing lines, they are unlikely to be provided,

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at all events at first, on lines recovered from the enemy or newly-constructed.

In peace, the absolute block system is enforced almost universally for passenger lines.

In war, permissive working will be adopted whenever the additional line capacity it affords is required.

On civil railways, the block telegraph and certain telegraph wires are entirely at railway disposal.

In war, though the same necessity exists for allocation of certain wires to the sole use of the railway, this may not always be adhered to. Traffic working, however, is entirely dependent on the telegraph and line clear message system, unless electric block instruments have been installed.

These obvious differences in peace and war conditions do not, however, indicate that the general principles which have resulted from experience in civil practice do not hold good in war.

Even the dethroning of the paramount factor in peace—finance—is more apparent than real.

Time is the governing factor set up in its place which makes speed of construction all-important, and necessitates the less strict adherence to technical standards and "safety first" methods. That time is money requires, perhaps, to be kept in view even more in war than in peace.

The general principles of efficient working must be always adhered to. Efficiency and economy go hand in hand.

My object in enumerating these differences between peace and war conditions is not to suggest any general justification of the relaxing of peace time technical standards or standards of safe working, but rather to indicate the need of versatility, adaptability, judgment and decision in the military railwayman of all grades. His work cannot be governed by such rigid standards as in peace.

It is essential, in war, that all ranks should be able to take the necessary responsibility. This necessitates a proper appreciation of the position, and this again requires training and experience.

I have already pointed out that railways are a link, or rather a series of links, in the transportation chain. Each of the railway links must then be at least equal to the strength required of that chain.

The weak points in the railway links of the chain may be individual sections of the line, with heavy ruling grades and sharp curves, necessitating reduction in train loads. All possible steps must be taken, of course, to improve the capacity of these sections, but it is at the junctions of individual links that congestion may occur. These are the possible bottle-necks to be avoided.

In war, the traffic is mostly special—ammunition, ordnance stores,

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supplies, etc. These must be stored in great bulk in railway-served depots and must be somewhat dispersed in those depots, in order to localize damage from air attack. Hence, the necessity of large railway-served areas for storage, and large railway yards, wherever bulk storage may be required. Congestion will otherwise occur. The most important of these large storage areas are the base depots. The proper lay-out, initially, of base depots of adequate size, and with room for expansion, is the first and most essential step towards satisfactory railway working in a theatre of war. A badly laid out base depot area, or depots of inadequate size, will cramp transportation style from the very outset, for it will hamper the clearing of the docks. No congestion of docks or of railway yards should be permitted. Hence, the necessity of ample facilities to clear them, and of depots to accommodate the vast tonnage of stores, etc., required by a modern army. These are the reasons why it is invariably found that an extensive railway-served depot lay-out, hundreds of acres in extent, is required at any base port, notwithstanding that the commercial tonnage handled at that port, in peace, may greatly exceed the tonnage of army stores to be handled. The tonnage is not for the most part for immediate dispatch up country, nor can it be stored in the dock area—this must be kept clear for transit purposes—nor in adjacent warehouses, if any, which would be unsuitable for housing military stores. Further up the line, if any bulk storage be required, advanced depots of similar lay-out to the base depots and of adequate size, must be provided. Regulating stations and railway yards must be of ample capacity not only for the normal flow, but for periods of intensive flow, when also such intensive flow may be checked.

It is quite impossible to visualize any definite set of conditions on a war railway.

The country may be densely populated by a civilized community, and may be intersected with a network of double line railways, equipped with the most modern plant and apparatus. It may have no railways at all, initially; whilst every variation between these two extremes may be met with.

Consider the varying conditions that obtained during the Great War in France, in Salonika, in Mesopotamia, in East Africa, in German South-West Africa, in Palestine; in South Africa during the Boer War; in the Sudan campaigns, 1896–98, and on the Indian Frontier in the Afghan War of 1919.

It is easy to enlarge on the difficulties and diversities of the railway problem. We do not know even the gauge, or gauges, of the railways we may be operating and constructing. The country may be easy, or difficult, from a construction point of view. It may be largely waterless.

The base and points of contact with the enemy may be com-

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paratively close. On the other hand, there may be a L.-of-C. many hundreds of miles long, and, therefore, some days' journey between the base and the front. There may be several lines of communication or only a single trunk line which must carry everything for the army in the field, and possibly also for a civil population, large or small.

The operation of the railway, up to railhead, in British or friendly territory, will initially be in the hands of the normal civil agency or agencies. Various methods of working may be adopted, according to circumstances, on the arrival of the B.E.F. The civil authorities may continue to operate and reconstruct, or newly construct, as the troops advance, assisted only by the railway troops, as and where required. A definite length of railway may be taken over by the military railway authorities, *e.g.*, the hundred miles immediately in rear of railhead, and all new and reconstruction work may be undertaken by military personnel. The military railway personnel may take over the whole working of the line, retaining, in whole or in part, the civilian staff. There may be a combination of these systems of working.

We cannot say we will adopt the British Railway rules and regulations, or those of any other railway. We must begin with what we find and we may have to continue throughout, to work under the existing technical organization according to the local rules and regulations. It is quite clear, therefore, that in every case the existing rules and regulations and method of operating will remain in force, at all events initially.

The need of a flexible organization, and of a very broad unprejudiced outlook on war railway problems, is plain.

Having considered a few of the points of difference between war railway working and peace time operation, let us turn to the lessons of war railway history.

The part played by railways in war, up to the beginning of the Great War, is given in some detail, in a very excellent publication, *The Rise of Rail Power in War and Conquest, 1833–1914*, by the late Mr. E. A. Pratt, which was published in 1915. I am indebted to it for some of the following historical references.

Time does not permit of a review of the earliest opinions as to the strategic value of railways and their use in war, nor to trace the progress in the effective use of railways and in military railway organization in the wars of the last 100 years.

We will confine our attention to the American Civil War, 1861–64, the Franco-German War, 1870–71, the South African War, 1899–1902, and the Great War, 1914–18.

Suffice it to say that, in the earlier wars, troop concentrations had been carried out more or less expeditiously, but there was a lack of organization, and arrangements to deal with the transport of supplies and stores were faulty.

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The importance of railways in the American Civil War, 1861–64, is at once obvious. The area of operations was nearly as large as Europe. The lines of communication were some thousands of miles long and the country for the most part was only partially developed. The railways, in addition to their importance for strategical movement of troops, were vital for the maintenance of the armies. Many battles were fought, primarily for the control of particular railways, for the safeguarding of lines of communication, for the possession, more especially, of important junctions. Nevertheless, it was not until January, 1862, after a considerable period during which efficient and successful operation of the railways had been rendered impossible, owing to the want of proper organization and resultant interference by local commanders, that steps were taken to create an organization for efficient railway working and construction. The organization then introduced may be said to be the forerunner of military railway organizations which have proved successful in more recent years, and to be the basis of present-day organization. The necessity of a proper railway organization was not, however, fully realized, nor its introduction appreciated, by individual commanders, who were ignorant of the intricacies of the railway machine, and still imagined, apparently, that they could interfere with the working in their own areas, without dislocating the railway as a whole.

In the later stages of the Civil War, the railways being now properly organized, and local commanders no longer interfering in the technical working, there were many notable achievements, not only in the carrying out of large strategic troop movements, but in the transport of supplies, stores and ammunition required for their maintenance, and in the engineering work undertaken—bridge building, construction and both provision and repair of rolling-stock.

Such is the progress which followed recognition of the facts that the maintenance of a force must receive adequate attention conjointly with its movement; and that a centralized organization for handling the whole business of transportation, and one free from local interference, is essential to success, if success is dependent on efficient transportation. And what success in these days is not so dependent?

In the Franco-Prussian War, 1870–71, Germany's more efficient regulations for the control of the military railway machine and her superior war railway organization contributed largely to her military success. The lessons of earlier wars had not been neglected, but had not been fully learnt. Thus, as the German advance continued, the military railway organization proved inadequate to repair and operate the railways in occupied territory, and supply arrangements again broke down. The situation on the French railways was far worse, due to the inefficiency of their organization.

Both countries profited by the experience gained. As a result,

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both France and Germany remodelled their war railway organization, which included not only railway troops for construction, repair and operating, but an organization to control the military use of the railway service, to determine priority, and to be intermediary between the army generally and the technical staff.

The necessity for a control organization in addition to the technical agency for railway working has been recognized in the British Army. In the South African War, and for the most part in the various theatres of operations in the Great War, these duties were undertaken by a more or less distinct branch of the Railway or Transportation Directorate. They are now a function of the Movement section of the "Q" Staff, and are no longer a railway or transportation responsibility.

In the period 1882–98, during the wars in Egypt and the Sudan, British military railway history was made. The expedition for the relief of Gordon was the occasion of the raising of the first R.E. Railway Companies, the 8th and 10th. In the advance in the 1882 campaign, and more particularly in the later war, which culminated in the victory of the troops under Lord Kitchener at Omdurman, success was largely dependent on rail transport as well as on transport on the River Nile.

In the South African War, 1899–1902, railways were a material factor in the success of the British forces. Major Girouard, R.E. (now Colonel Sir Percy Girouard), who had been responsible for the railway work in the Sudan campaign a year or two previously, was appointed Director of Railways. Thanks to his previous study of war railway history, to the fact that he, at all events, had learnt the railway lessons of the American Civil War and of the Franco-German War, and to his organizing powers, the British did not have to buy experience all over again at the expense of initial mistakes and failures. The organization he created provided not only for repair and construction and for the technical working of the railways, where necessary in Cape Colony and later in the occupied territories of the Orange Free State and Transvaal, but for a Military Railway Controlling Staff, whose duties, to all intents and purposes, were to see that the best possible and maximum use of the railway facilities was made. They were the co-ordinating link between military requirements and the technical services, always working in the closest possible co-operation with the technical railway staff. The necessity for this link of military control is now recognized in official regulations, its duties being fully defined in the *Manual of Movement*, 1923, but there were no such regulations in 1899.

Minor modifications in organization were, of course, necessary in South Africa, as the result of experience, and new organization became necessary as military operations progressed; but there was never the need for wholesale reorganization, as in the United States

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in 1862, or on the Continent after the 1870–71 War, due to previous attempts to work contrarily to the principles of efficient transportation.

In the later, guerilla, stage of the South African War, a fleet of armoured trains played a considerable part in the military operations. It will be realized that the use of the railway itself as part of the fighting machine introduces considerable complications into normal railway working.

The outbreak of the Great War, 1914–18, found Germany prepared. She had a railway organization ready, and railway construction and operating troops available. Thus, from the outset, railways played their part efficiently in the concentration of troops and in rapidly following up the initial Allied retreat. It would, however, have been much more difficult to have followed up the retreat of the Allies, had it been possible for them to have undertaken more complete destruction; von Kluck might have overrun his communications earlier.

France, also, had learnt the railway lessons of 1870–71. In the early stages of the Great War her railway preparations were on the whole adequate.

It is sometimes represented that the fact that such vast British transportation organization subsequently became necessary, indicates failure in this country to appreciate, prior to the War, the importance of the transportation service. The answer to this is, I think, to be found in the model success of those transportation services for which Britain was responsible, *viz.*, the mobilization, concentration and dispatch of the E.F. France undertook to provide and operate the necessary transportation services in her own country. Later, certainly, these did not suffice. As with every other service, it was subsequently necessary to create vast organizations to deal with transportation and railway problems, not only on the Western Front but in all other theatres of war.

The problem on the Western Front was its concentrated intensity under the conditions of static warfare.

A force of 2,700,000 men had to be moved as required and to be maintained. The daily maintenance tonnage, including all stores, approximated 25,000 tons per diem. An initial British railway strength of approximately 400 increased to over 35,000 skilled railway troops, whilst some 1,400 locomotives and 50,000 trucks were obtained. A more or less static front during the greater part of the War did not, however, mean that no railway construction had to be undertaken. On the contrary, the total mileage of new (standard gauge) line constructed was approximately 2,000 miles. Mention should also be made of the considerable use of the railway to provide alternative firing positions for heavy guns, mounted on specially designed railway trucks.

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On the other fronts, mostly under conditions of mobile warfare, in German South-West Africa, in the Balkans, in Palestine, in Mesopotamia, and in East Africa, the railway had to follow up the advancing troops. Existing railways had to be repaired, or new railways to be constructed, and to be operated, often under pressure of maximum traffic, as soon as they could be opened. There were some 10,000 railway troops and approximately 50,000 non-Europeans employed on railways in these theatres of war. Approximately 2,000 miles of new routes—probably involving over 3,000 miles of actual track—were constructed, partly in difficult and waterless country. Throughout, the British followed up their South African experience in the creation of a branch of the Transportation, or of the Railway, Directorate, to receive and co-ordinate demands on the railway—a link between the army generally and the technical branches—in addition to raising distinct technical branches and units for construction, operating and repair.

I will not enlarge on the railway activities on the various fronts during the Great War. A complete history would fill many volumes and may yet, I hope, be written. These brief reviews indicate, however, how large a part railways have played in the wars of the last three-quarters of a century, and that they have been largely, if not chiefly, responsible for the ultimate victory in several campaigns, also that a centralized military control as well as a complete technical organization is essential.

It is obvious that railways can only be controlled as a whole by G.H.Q. Hence, they must be a centralized G.H.Q. service: control and administration cannot be arbitrarily sub-divided, geographically, according to military areas of control or administration. This necessity for a central control, without interfering with the technical working, is one of the chief lessons, if not the chief lesson, of war railway history.

Apart, then, from such obvious necessities, alike in war as in peace, that a railway must have a sufficient capacity for the traffic to be carried, and adequate engines, rolling-stock and equipment, the principal lessons of war railway history may, I think, be summed up as follows:

(*i*) An adequate centralized organization to control utilization and to prevent local interference with the technical working.

(*ii*) An adequate technical personnel, fully trained and sufficiently versatile to realize that the railway is part of the army machine, and that essentially railway interests are no longer paramount.

(*iii*) Recognition of time as the all-important factor.

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This at once emphasizes :

(*iv*) The importance of early information as to policy.

(*v*) The importance of rapid survey and construction work, involving a capacity for improvisation.

(*vi*) Less stringent " safety first " precautions.

Let there be no mistake that improvisation and reduction of safety appliances involve either the waiving of principles or the introduction of slovenly methods. Only those who know proper and best practice in survey, construction and railway operation can adequately improvise.

Appreciation of the all-importance of time teaches :—

(*vii*) the necessity as much for wholesale destruction in retreat, as for rapid construction on advance.

Highly important technical lessons are :

(*viii*) Do everything possible to avoid congestion.

(*ix*) Look ahead when designing, so that expansion may be practicable if traffic should increase.

In my experience of railways in war, I have never known of a new railway or branch which was not required to carry, very soon after opening, a greater tonnage than the maximum estimated by the staff.

(*x*) Make lay-outs, depots, yards, water supply installations, etc., sufficiently large to cope with checks and uneven flow during periods of intensive traffic.

(*xi*) Provide very adequate facilities for engine and rolling-stock repair.

This is particularly important in a distant theatre of war, or where the gauge of the railway is such that additional rolling-stock is not easily obtained.

(*xii*) Have adequate plant and material available, *i.e.*, look ahead and be prepared.

This provision of adequate plant includes construction plant and special rolling-stock and tackle to carry, to load and off-load, and to handle all special military traffic, *e.g.*, tanks, guns, other heavy or bulky loads, petrol in bulk, horses in large numbers, etc.

Railway preparedness for war is naturally divided into two main divisions ; what can be done in peace and what must be delayed until hostilities are imminent or war breaks out.

However ready may be our organization and our railway troops,

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on the plant, stores and material side, it can never be hoped to be fully prepared. In the first place, complete stocks cannot be determined when neither the gauge of the railway nor the length of the L.-of-C. are known ; and even if these were known, it could not be afforded to hold vast quantities of plant, stores and material in peace. What can be done, however, is to be so far prepared with railway intelligence and with complete lists as to be in a position to order all that is wanted as soon as the locality is known and the emergency arises. Many of the stores will be readily procurable.

Now let us just glance at existing organization with particular reference to these lessons.

Present day organization is set forth in *F.S. Regulations*, Vol. I, and in the *Manual of Movement*. It makes transportation, of which railways is a sub-directorate, a centralized G.H.Q. responsibility. It provides also for the control and utilization of transportation services by the " Q " Staff, whilst the technical organization includes Transportation, Railways, Docks and I.W.T. Directorates, as may be required.

In no two wars are the transportation or railway conditions alike. It needs no emphasis, bearing in mind the very varying conditions which may be met with in different theatres of war, that the British military railway organization must be elastic and adaptable to local conditions. It is obviously impossible to have numerous alternative regulations. Regulations, nevertheless, must go into some detail.

The *Manual of Movement*, mainly based on conditions such as existed in the later stages of position warfare on the Western Front, has chiefly in view several short, or comparatively short, Ls.-of-C., more or less of a network of railways and numerous railheads. With the very altered conditions of a long single railway as L.-of-C. these regulations may require adaptation to the individual theatre of war.

Hence, the importance of the study of the history of railways in war, both by the Staff and by the technical railway officer. Particularly, it is necessary for the officer at the head of the Movement section of the Staff in war, and for the senior officers in each of the Transportation Directorates, to bet horoughly conversant also with the regulations. Then, while carefully guarding the principles of sound transportation, they will be quick to interpret such detailed modification of procedure as local conditions may necessitate. I have already drawn special attention to the necessity of adaptability in the military railwayman, and this applies to all concerned in the proper working of the railway machine in war. If they are adaptable, the special provisions necessary in any particular theatre of war will be introduced in anticipation, instead of being forced upon them later as the result of experience, and perhaps at the expense of initial failure.

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Regulations must be definite, but everyone must be progressive, always on the look-out to improve and never satisfied with the dictum that because things were done this way in the last war, they must necessarily be done the same way in the next.

As regards the directorates, war establishments for all of them have been prepared, and peace establishments include railway troops for survey, construction, operating, shop work, stores and also for dock working. The composite and survey units are raised from Regular sources, and the other companies are Supplementary Reserve units, raised by the four British Railway Groups.

It will be obvious, however, that transportation requirements will vary according to the theatre of war. Directorates and units not required need not be mobilized or raised.

It might be suggested, since you do not know your theatre of war, or your gauge, why not consider separately every likely, or possible, theatre of war and have a different organization for each, according to the circumstances, making use, in British territory or in a friendly country, of the local railway authorities and their staff as far as possible? These, presumably, know and would work their own railways better than any imported troops?

Or, it might be suggested, why make any railway preparation at all, seeing your problem is so varied, and war, we hope, so remote? Think of the economy thereby? Wait until war breaks out and then improvise as fast as you can?

The answers to these suggestions are, I think :—

Firstly, that time, often the most important consideration in war, may never again, in these days of speeding up in every direction, admit of any breathing space in which to create or to perfect an organization.

Secondly, that we cannot depend entirely on an unknown quantity, and cannot, therefore, be wholly dependent on any local organization.

Thirdly, that our organization, though it cannot be full and complete, must be elastic and that it does take into consideration that the local railway authorities may very largely be employed in the construction and operation of the railways, in the various possible theatres of war; and,

Fourthly, that if we are to start off at 100 per cent. efficiency, which may be necessary, we must have a trained military organization, a military nucleus who realize the essential differences between military and civil transportation problems, a versatile and adaptable body of men who are soldiers as well as railwaymen.

The question then becomes, shall we train soldiers to be versatile

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railwaymen, or shall we train railwaymen to be more versatile and to be soldiers?

Under the present organization, it is attempted to train a small number of Regulars to become versatile railwaymen, whilst certain of the Supplementary Reserve railwaymen undergo a fortnight's training, every year, at the Railway Training Centre, Longmoor, to improve their military knowledge and to learn some of the possible differences and variations from peace time practice which may confront them in war.

It would be impossible, obviously, to raise any considerable body of Regular railway troops in peace.

Firstly, the cost would be prohibitive.

Secondly, a commercially run railway would be essential to their training.

Thirdly, their colour service would have to be long, unless they were trained railwaymen on enlistment; and if they were railwaymen on enlistment, why not, for the most part, leave them as such, teach them the necessary versatility, and make soldiers of those of them who were not already soldiers?

Some railwaymen, who live in the military atmosphere, are, however, essential, to be immediately available in the small emergency in which but a handful only of railwaymen are required, and for which it may not be desired to call up any Supplementary Reserve from their civil employment. They are also required to form a training centre and depot for all military railway units. Hence, the two Regular R.E. Companies. Hence, also, the training of Regular officers as and when opportunity offers, firstly, on initial courses at the Railway Training Centre and on Home railways, and subsequently on Colonial railways, or more particularly on Indian railways, not only to fit them to officer these units but to train them to fill the important positions in the Transportation and Railway Directorates in war.

The bulk of the railwaymen who will be required to accompany the B.E.F. are in Supplementary Reserve units, raised in peace by the Home Railway Companies, to whom also we look to supply the Army with such additional units as may subsequently be required.

The training of railway troops at the Railway Training Centre, Longmoor, is designed to give that changed outlook, that versatility, that capacity for rapid work, the importance of which has been emphasized.

Thus, it will be seen that in the B.E.F. transportation organization of to-day, it is endeavoured to put into practice the lessons of the past and to be in a state of readiness so far as is practicable, both as regards organization and personnel.

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THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR, 1914–18.

(Continued.)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART V.—FEBRUARY, 1917—APRIL, 1918.

Battle Honours during the period—" Ypres, 1917," " Passchendaele " (2nd battle).

EARLY in February, 1917, the extension of the British line southwards commenced and the III Corps took over from the French 18th Corps in the Bois de Boulogne area (Sketch No. 21). The 23rd (Field) Company marched with the 2nd Infantry Brigade from Warloy *via* Baisieux, Ribemont, Cerisy, Morcourt to Mericourt-sur-Somme. The following day, the Brigade group marched to Moulin de Becquincourt, marching past Gen. Herschauer, 18th French Corps, and Gen. Pulteney, G.O.C. III Corps, on the way. That night, Gillespie and a reconnaissance party went forward to the Bois de Boulogne to take over from the French *Génie.*

Normal trenchwork ensued, deep dugouts, machine-gun posts, defences in Corps line and improvements to horse lines, shelters, and so on in rear areas.

On 26th February, the Company was withdrawn into reserve at Chingnolles, and on the 28th the Corps Commander presented the ribbon of the D.C.M. (gazetted 1st January) to C.S.M. F. E. Simmonds, who had already, in October, 1916, been awarded the Meritorious Service Medal. C.S.M. Simmonds, who went to France with the Company as Saddler-Corporal, had been promoted to C.S.M. *vice* C.S.M. Hudson, D.C.M., in the summer of 1916, the latter having been promoted R.S.M. 35th Division. C.S.M. Simmonds' work, " particularly as section-serjeant, had been consistently of a high standard, and his example to those under him in times of danger and of difficult work was beyond praise." His many friends, including all those officers who served with the Company immediately before the War, feel no surprise that he should have collected so many honours (he was later to win the bar to his D.C.M.), for this splendid, energetic and self-reliant N.C.O., with quiet yet forceful personality, was typical of all that was best in those fine N.C.O.s who have always formed the backbone of the Corps, and have contributed so much to its high reputation.

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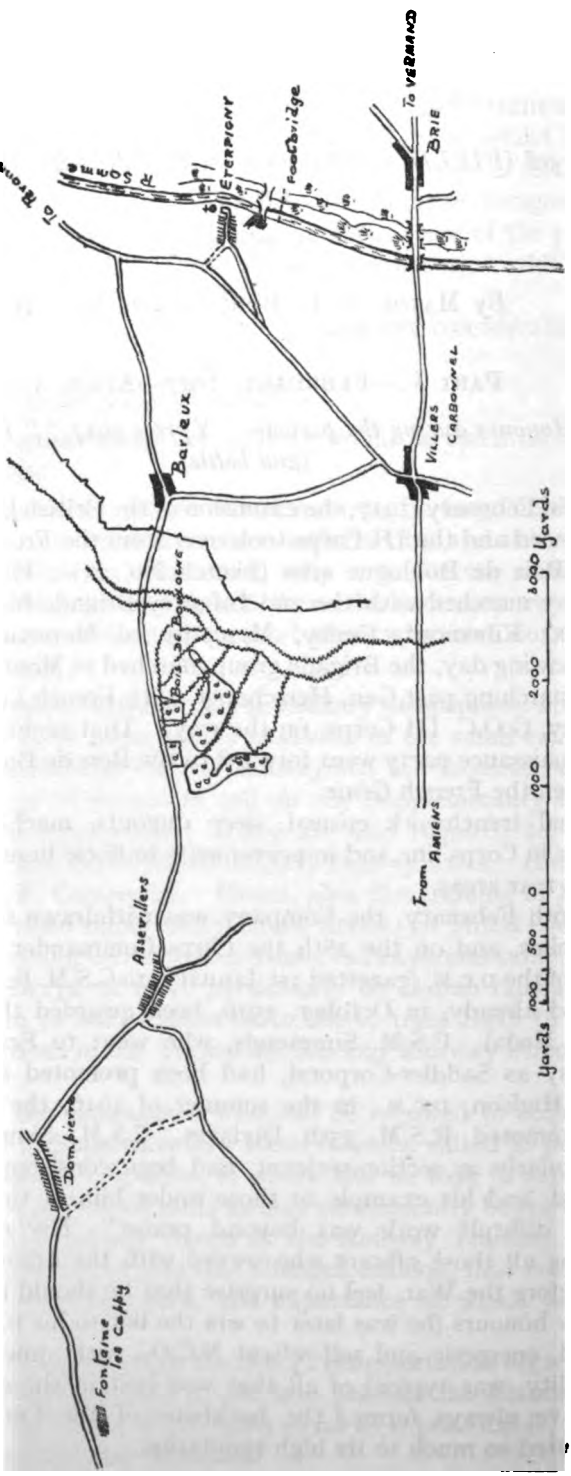
SKETCH No. 21.

BARLIEUX—BRIE. 1917.



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On 5th and 6th March, the Company again moved to the forward area, and was joined by 100 infantry for working on roads which now assumed the greatest importance. On 12th March, Cohen left the Company, Edwards becoming second-in-command.

On the night of 16th March, a raid on a big scale was carried out by the 10th Gloucesters on the right and 1st Camerons on the left, Cowley and a party of Sappers (No. 2 Section) going with the right battalion and Smith with his party with the left battalion. In order to make the necessary gaps in the enemy's wire, Bangalore torpedoes were brought up, but the Camerons got forward successfully without their use. On the right, Serjeant Elcombe went out with two Sappers at 4.0 a.m., and with great gallantry and in spite of German machine-gun fire, which severely wounded him, succeeded in putting his torpedo in place with leads connected. The serjeant was, however, caught by our own barrage fire, and was unable to fire the torpedo, and with much difficulty just managed to get back to our lines. Cowley, however, then went forward, fired the torpedo, and created a gap ten yards wide, through which the infantry were able to advance. For his gallantry on this occasion Serjeant Elcombe received the Military Medal.

The Advance.—Eterpigny and Brie Bridges.

On the following day, 17th March, the good news was spread abroad that the enemy were on the point of making off; all the energies of the Company were directed to pushing on forward roads and the construction of trench bridges suitable for artillery. Dozens of trees had fallen or been felled across the roads and had to be removed. The enemy's withdrawal was already in full swing, and at 9.30 a.m. on 18th March Smith and Cowley were ordered forward to Eterpigny to reconnoitre the Somme bridges. Cowley returned later on with his report and took his section to Eterpigny, commencing work at 2.0 a.m. on the 19th. In the first place, a footbridge 300 yards upstream from the main crossing was repaired, and by 9 a.m. two companies of the 1st Infantry Brigade were across the Somme.

The weather was very wet, but work nevertheless went on till 10.0 p.m. On the following morning, all four sections were employed on the main bridge to make it fit for field guns. It was evident that it had been very fully used for transport by the enemy, the decking having worn thin. The bridge was well demolished, particularly at the larger water gaps, partly by explosives, partly by fire, and much tarred firing was found in position. Several packets of howitzer charges were found wrapped in wood shavings, and a few packets of explosives were discovered intact. The total length of the bridge was 1,600 ft., including the canal bridge and approach ramps, and of this some 700 feet had been destroyed. The

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river was partly canalized, partly flowing fast in its normal bed, with a marshy strip on the east.

The bottom of the marsh was most treacherous, piles sinking 12 ft. to 15 ft. with a hand maul, whilst trestles gave much trouble owing to shell craters, demolition craters and " dud " shells.

Work on the bridge continued throughout the 20th and the morning of the 21st, being opened for field gun traffic by 1.30 p.m. on this day. In construction it consisted of a mixture of pontoons, Weldon trestles, pile piers and wire-lashed trestles.

As soon as this work was complete, all sections were switched on to road-making on the Barleux and Villers Carbonnel roads, but on the 23rd, owing to the trouble due to sinking piles and the failure of the old decking, all sections were again employed on the Etrepigny bridges.

On the 24th, the 23rd (Field) Company was diverted to work on the Brie bridges, where, on the main through route, it was essential to have a bridge fit to take all loads.

The whole of the 24th was occupied in clearing the debris of demolished girders from the bed of the main stream by demolition, excavating for the new abutments, and driving piles to act as temporary abutments, the latter work, including laying timber footings for crib work of the abutments, being continued on the 25th.

The main bridge consisted of a Portable Type B bridge, of 60 ft. clear through span, each girder in sections bolted together. In the first instance, in accordance with the instructions of the III Corps Bridge Engineer, foundations 20 ft. x 14 ft. were started; these were found to be too deep. The timber footing was eventually 16 ft. x 10 ft.

The girders were launched singly from the west bank, using a steel lattice derrick, and no difficulty was experienced in this operation. The girders were in place by the evening of the 26th, and all decking was completed and bridge open for traffic by midday on March 28th. The main difficulty that had arisen was due to the fact that only one set of plans had been provided with the bridge. This set had to be shared with the 26th (Field) Company, the drawings were on thin paper, and as the weather was very wet the condition of the plans after a short time can be imagined.

That the work of getting this big bridge into position was achieved so quickly and well was in large measure due to the ability and experience of Wilson, the O.C., who had done much railway work in civil life.

As soon as this bridge was complete (Bridge No. 5), a light semi-permanent timber bridge, parallel to it, was constructed on piles to take some of the lighter traffic.

On this day, the following wire was received from III Corps: " Army Commander expresses his high appreciation of the energy

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and skill shown in the early completion of the Brie crossing. Corps Commander endorses this, and desires to be conveyed to the C.R.E., Field Engineers, Bridging Detachments and Field Coys., 1st Bn. Northants, details R.A., and L.N. Lancs., whose efforts have obtained these results."

Later on, the following encouraging message was received :

"A most valuable piece of work which has been of the highest importance to the Army, by enabling the enemy to be followed up with the least possible delay. I request that all concerned may be informed of the value which I attach to the success of their efforts.

D. HAIG,

4th May, 1917. *Field-Marshal.*"

To celebrate the occasion, a combined dinner was held by the 1st D.E., which was attended by General Buckland, Chief Engineer 4th Army.

Bridge No. 5 having been completed, work was required on advanced Army Headquarters at Villers Carbonnel, where the village had been entirely obliterated.

On April 1st, the rapid flow of the stream having undermined the trestles of Bridge No. 5 (medium bridge) at Brie, the Company was diverted to this bridge, the work being completed in spite of heavy snow and blizzards by April 5th.

On April 6th, work was commenced on a bridge which had already been started at Lamire Farm. The work was in a very bad condition. The original German bridge had been partly pile, partly crib pier, demolition had been thoroughly carried out, half a dozen field companies had already had a finger in the pie, and the whole thing would have provided a puzzle to the most expert spillikin player.

A new line was, therefore, set out, avoiding the worst portions of wreckage, a 20-ft. pile-driver with half-ton monkey was brought down from Brie Bridge and re-erected on a two-pontoon raft, and two small pile-drivers were also utilized. A deviation footbridge was constructed to keep traffic off the main bridge.

Pontoons, which had been in bridge over the eastern main channel, were taken out to allow piling, and first a 24-ft. pile (made up of two piles strapped together) was driven to 1 in. sinkage with a 4-ft. drop of the 10-cwt. monkey. Work was well under way when, on April 7th, orders were received to stop work on this bridge, then to put all pontoons in the water and get a bridge through quickly, then another order cancelling the last. Finally, two sections were left to complete the Lamire Bridge as a footbridge only, one section was diverted to Eterpigny Bridge to replace the pontoons by 40-ft. pile piers, and one section was taken out for training under the section officer.

Eterpigny Bridge was completed on April 12th.

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On April 17th, the Company moved to reserve billets at Mericourt, where the ensuing fortnight was spent in Company training. On April 20th, the Corps Commander inspected the unit and presented the ribbon of the Military Medal to Serjt. Elcombe.

On May 2nd, the various sections went off on different jobs, No. 1 (Lieut. Wales—attached from 26th Fd. Coy.) to Carnoy to take down XIV Corps H.A. headquarters, No. 2 (Cowley) to Mericourt to dismantle the XIV Corps main dressing station, and Nos. 3 and 4 Sections (Forwood and Smith) to Nurlu to work on a new aerodrome.

On May 27th, the Company entrained at Marcelcave for the north, and after spending ten days at Thieushoek, near Caestre, and ten days near Cassel, marched on June 19th and following days to Coxyde, on the Belgian coast, where work in the Nieuport Bains sector was taken over from the Field Companies of the 32nd Division on June 22nd.

THE COASTAL SECTOR.

The area in which the 23rd (Field) Company now found itself was quite unlike any other part of the line. One flank rested on the seashore at Nieuport Bains, at the mouth of the Yser river.

The strip of sand dunes running the whole length of the coast from Ostend to Dunkirk varied in width from a few hundred yards to nearly a mile. On the sea side, the shore consisted of miles of fine firm sand, but bathing east of Coxyde was prohibited by day owing to being overlooked by the enemy, and by night by the activities of sentries. Even west of Coxyde, where a bend in the coast hid the beach from direct observation, bathing was apt to be a somewhat lively performance; on one occasion, the inhabitants of La Panne were shocked at the appearance of an entire battalion, kilted in more normal moments, arriving at a steady double on the sea front, with not even a sporran amongst them, having been temporarily cut off from its clothing by a minor barrage of 4·2-in. H.E. whilst bathing between La Panne and Coxyde Bains.

Beyond the sand dunes, which consisted of sandhills running up to thirty or forty feet in height, the country was flat and low-lying; water lay permanently within a foot or two of the surface, and any defences, except those in the railway embankment and in the sand dunes, consisted of breastworks.

Nieuport Bains consisted in the main of one long row of four- or five-storey houses joined together, separated from the shore only by the sea road. All these houses had excellent cellars, and these had been turned into a long underground passage by the French, lighted with electricity. This passage was continued towards our lines by a semi-underground passage dug in the sand, with a light timber roof about ground level which, although providing no cover from fire, yet hid parties and individuals from view and induced the spurious

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confidence of the ostrich. There were two or three of these curious passages running back nearly three-quarters of a mile from the river, and having been built apparently for troops less than 5 ft. 10 in. in height, the journey, for anyone over 6 ft., was productive of serious stiff neck. On the other hand, invisible O.P.s in the sand dunes gave both sides splendid views over the opposing areas, and movement above ground by daylight invariably drew unwelcome attention. Many of the houses in Nieuport Bains had suffered but little, and, for the more light-minded, billiards or a song and dance with piano were to be had in several places.

The work of the Engineers was mainly directed to the maintenance of communication across the R. Yser, for at this time two battalions were in the trenches on the east of the river, a satisfactory enough situation during the peaceful years of the French occupation, but actually as precarious as could possibly be imagined should trouble boil up, for the Yser at this point was fully 100 yards in width, with a rise and fall of tide from 10 ft. to 15 ft. Communication was by pontoon bridges, which were constantly broken by the enemy's artillery fire, and the maintenance of which was a task of unending danger and difficulty. An attempt was made to construct a floating bridge to take a decauville track, a somewhat optimistic operation. The conditions under which these bridges were maintained is exemplified by the fact that more than one Sapper was actively seasick whilst employed on the work. Carrying parties moving up to the front at low tide by night had great difficulties in negotiating the steep ramp, and occasionally men were drowned. It was hardly to be wondered at that when the enemy decided the time had come to remove our bridgehead the bridges were broken within a few minutes, leaving the isolated units without a fighting chance.

The 1st Division, on taking over the sector, had at once started to prepare the ground with a view to an eventual advance along the coast, and the programme of work issued to the C.R.E. was as follows (Sketch No. 22) :—

Maintenance Work.

Covered way marked —·—·—.

3 floating bridges over R. Yser.
Electric power station in Nieuport Bains.
Camouflage screens along road Nieuport—Nieuport Bains.

New Work.

(*a*) Erect camouflage screens A—C to hide river from the enemy, leaving room to form up four lines of troops between the river and the screen.

(*b*) Collect and make up into rafts, material for one medium and two footbridges.

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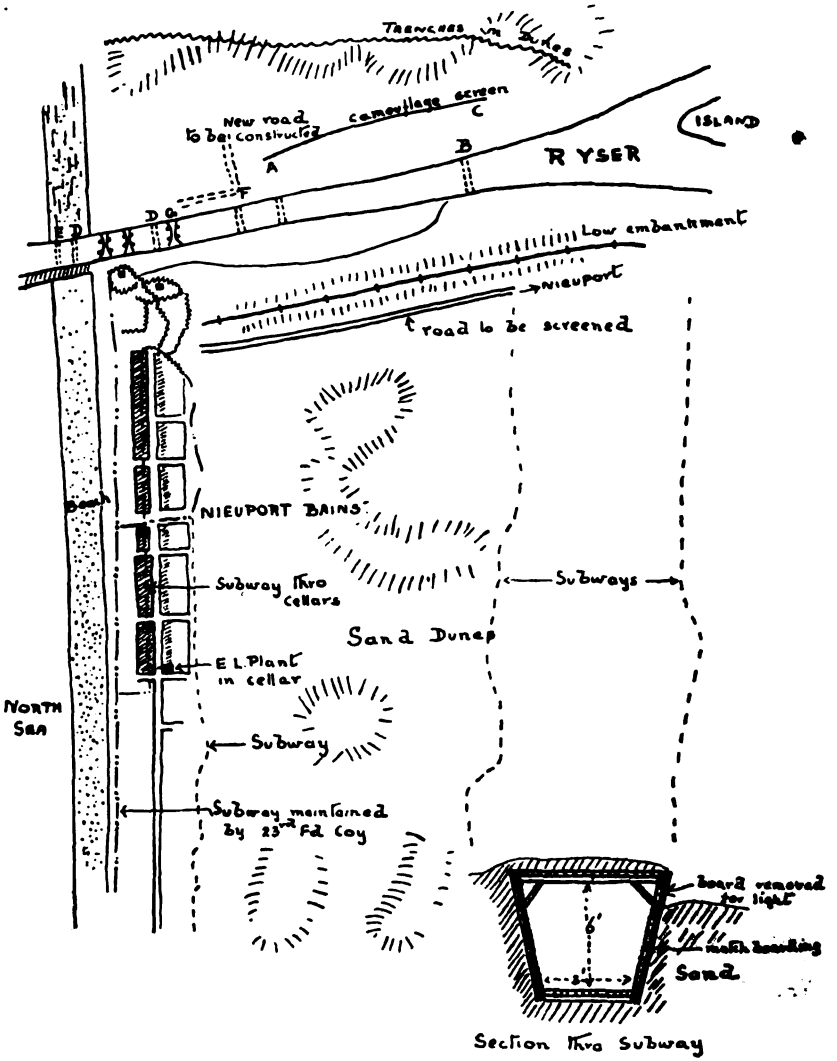
(*c*) Reconnoitre for footbridges at E, A and B, and medium at F. Ferries at D, D.
(*d*) Transport road to be made connecting with route *pavée*.
(*e*) Erect cupola shelters between E and G.
(*f*) Bomb-proof shelters at Div. H.Q.
(*g*) The greatest care to be taken to camouflage all new work.

NIEUPORT BAINS.

SKETCH No. 22.



On July 6th, 7th and 8th, work was handed over to the 458th (Field) Company, and the 23rd withdrew to Le Clippon, leaving, however,

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Lieut. Smith and two Sappers to take part in a raid opposite the right battalion at Nieuport Bains on the night of the 9th. No record of this raid exists, unfortunately.

Le Clippon Camp. (Sketch No. 23.)

Le Clippon, or "Hushville" Camp, was, as all the world now knows, the home of the 1st Division whilst training for the projected landing on the coast about Ostend, which never materialized.

The erection of this camp was carried out by Field Companies, accommodation being in Nissen huts.

The camp being situated in the dunes, water supply was an interesting problem. In the first instance, it was proposed to pump water from the pond and snipe bog into tarpaulin reservoirs, thence through sterilizers and by 4-in. pipes to distribute throughout the camp. For this purpose three miles of 4-in. pipe, and 3,000 yards of 2-in. pipe, were laid, and pumping engine installed. Unfortunately the pond, once emptied, refused to refill, and it became necessary to improve the snipe bog supply by cutting irrigation channels and sinking a cased well. At the same time, wells 6 ft. to 10 ft. deep were sunk at the rate of two per unit. Each well was provided with a L and F pump and a 200-gallon tank and these wells gave an average yield of 1,000 gallons per day each.

In addition, a reserve supply of 12 400-gallon tanks was maintained at the camp entrance, water sterilized at Zoon Plage being supplied by tank lorries and distributed through the camp by rail.

A further work carried out by each company was the construction of an obstacle course for its Brigade.

About this time there took place an epic football match. As happens in the best regulated families, there had been for some time a slight coldness between the 23rd and 26th Companies, and, to clear the air, it was decided that a match should be played by company teams of officers and N.C.O.s. Excitement was intense. To a supporter of the 23rd, armed with pebbles in a tin, the 26th replied with a gas rattle. The 23rd riposted with trumpeter and two friends with bugles. The crowd thickened, and every touch of the ball was greeted with enthusiasm, until the din reached the ears of Brigade H.Q., who, fearing a riot, turned out the guard, on which a cynical Sassenach was heard to remark that they must have thought the Camerons had got at the Black Watch at last! Finally, the match finished with loud cheers, and the hatchet was buried good and deep.

By Sept. 29th, it was apparent that the projected operations would not be carried out, and the Division left Le Clippon camp and moved into the forward area, Oost Dunquerque. The transport moved into Perth Camp, where a most unhappy event occurred, for the

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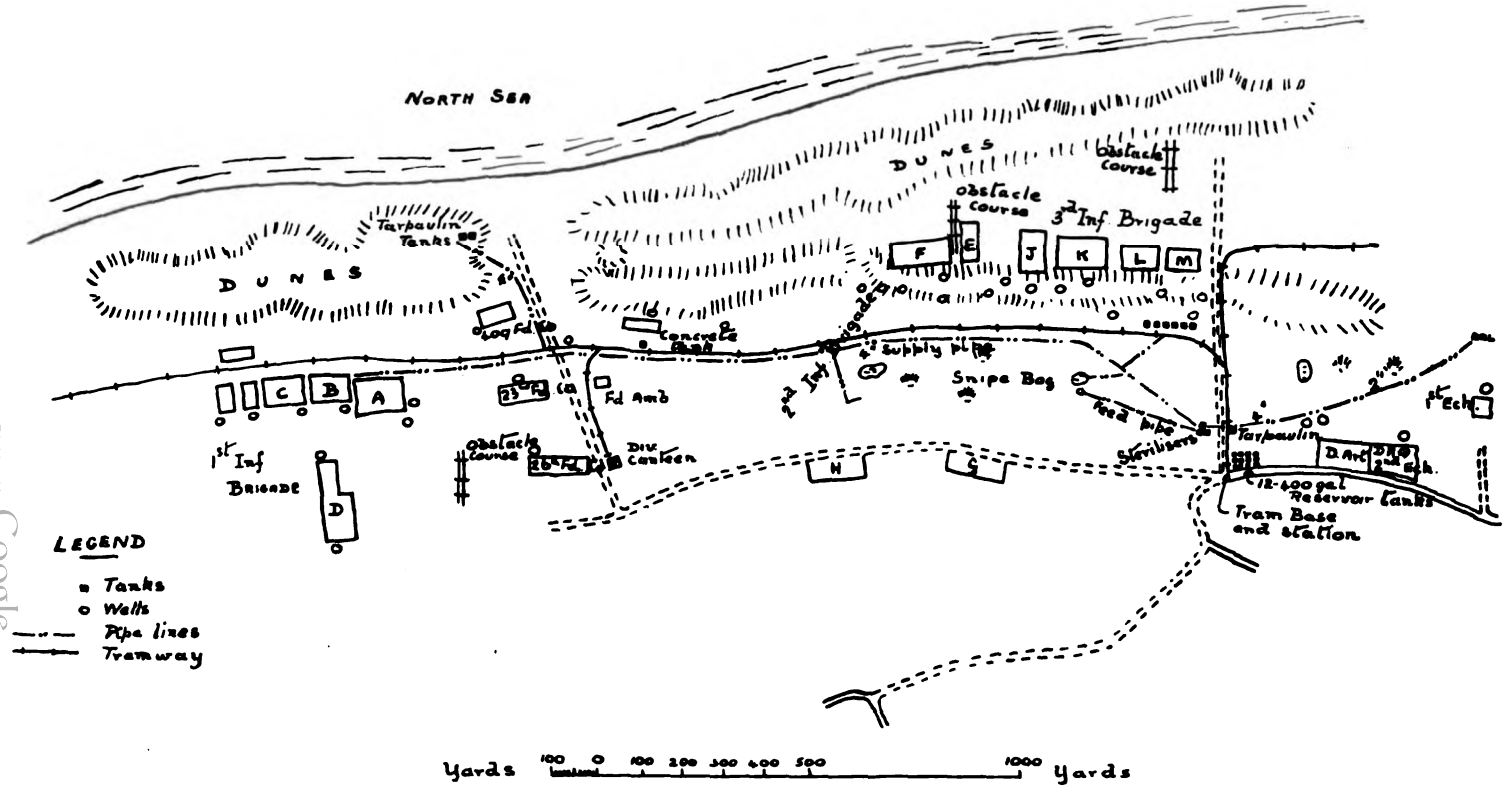
LE CLIPPON CAMP.—WATER SUPPLY.

SKETCH No. 23.



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horse lines were shelled, 29 horses being killed and 16 wounded. The lines were thereupon moved back behind Coxyde. Many old friends amongst the "hairies" were lost, but they had, poor things, never fully recovered from the effects of the winter on the Somme, and the well-conditioned lot of young remounts, if a bit untrained, were welcome.

YPRES, 1917. (SKETCH NO. 24.)

The 1st Division turned its back on the coast in the middle of October, the Company moving on the 18th to Ghyvelde, on the 22nd to Arneke, the 26th to Herzeele, and eventually on the 31st to the battle area, billeting in the first instance at Hospital Farm Camp, and a couple of nights later at Hill Top Farm Camp, the Division taking over from the 63rd Division on November 7th/8th. This pleasant-sounding name belied the reality, for here was no pleasant grassy meadow with neat rows of huts in the shelter of a peaceful farm, but a few tin shelters in a wallowing waste of water-filled shell-holes, a bare bleak swelling in the shattered plain, with here and there a concrete "pillbox" embedded to its eyes in the morass to mark where once a quiet homestead had been, now peeled like a nutshell from the sinister kernel within.

Almost nightly the camp was shelled by heavy high-velocity guns, and frequently bombed by aircraft, but by marvellous good fortune hardly a casualty was sustained, even though on one occasion a delay action 8-in. shell, having buried itself deep in the ground, lifted a Nissen hut complete with No. 4 Section into the air. Poor No. 4 were just sleeping off the effects of a heavy night's work in the mud. Spectators dashed to render first aid when No. 4 were seen crawling out of the debris in all directions, choking and spluttering, little the worse. The heartless C.S.M. was heard muttering, "That's all right, we've a full complement for work to-night, after all!" After this, C type steel shelters were built under the lee of pillboxes. Company H.Q. was in the canal bank quite close to the remains of the old barge bridge of 1914. The hulks were still there, but the old billet nearby had passed from mortal ken, and the barges had had a rough time in the previous three years.

The 23rd (Field) Company was now mainly employed on the construction of a forward road from about the Triangle to Genoa and the Strombeek. The aeroplane photograph, showing a portion of the Strombeek Valley in which the Company was working at this time, gives a clear indication of the difficulties of the undertaking, which consisted of filling in shellholes and making up a firm bed for the wooden slab road. In addition to the new construction there was a great deal of maintenance work owing to the nightly shelling. Movement to work was by duckboard tracks, sometimes laid on the ground, sometimes where the ground was more than usually flooded

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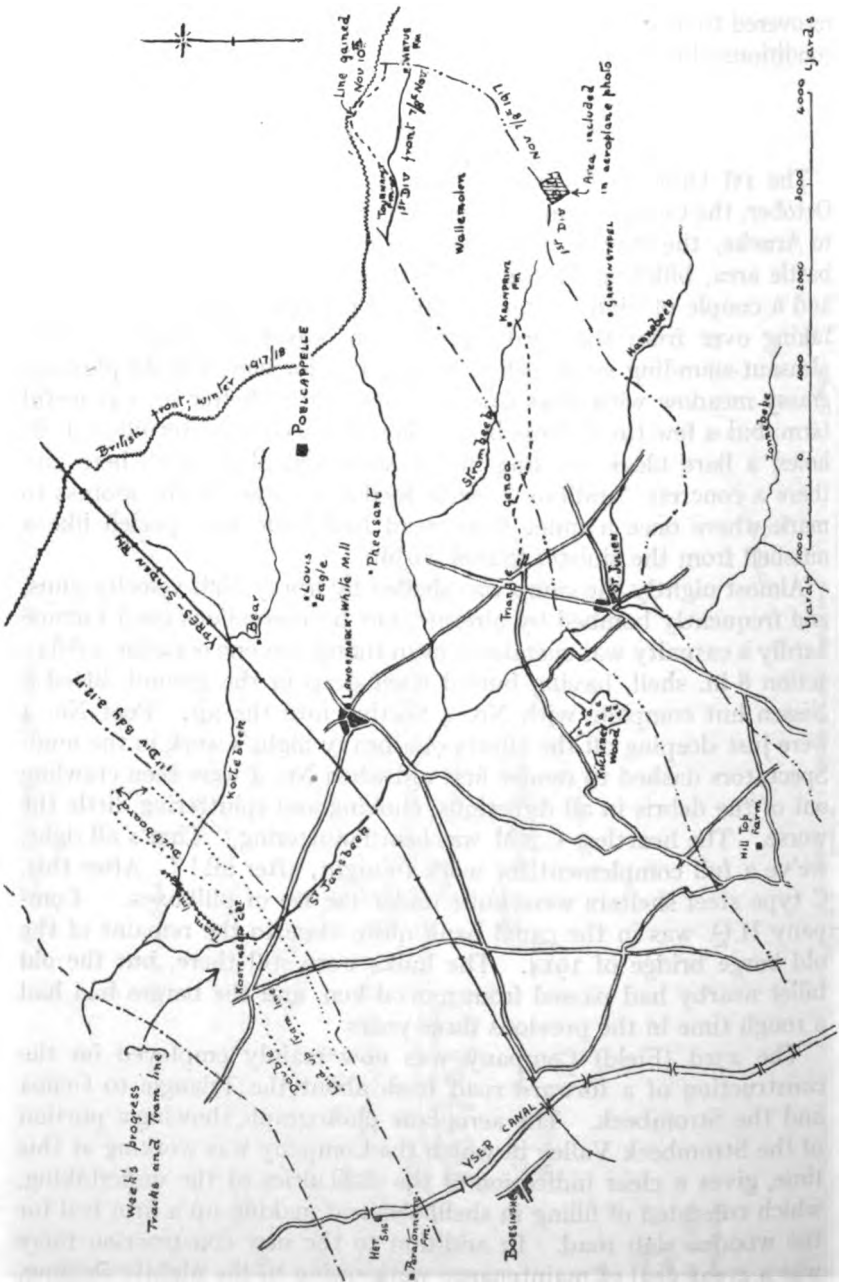
YPRES.—November '17—April '18.

SKETCH No. 24.



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raised on small piles, the route avoiding St. Julien, an unhealthy spot.

In addition to the work on the road, the construction of a tramway was pushed on as rapidly as possible, the 248th, 5th, and 226th (Field) Companies, R.E., and 14th Worcesters (Pioneers) being also employed on this work. In order to support the attack of the 1st Division on the 10th November, it was necessary to get 60 field guns into the Strombeek Valley and the railway was the only means of doing this, hence the urgency. The work was most difficult for the line had no connection with any existing system, and the materials had, therefore, to be carried forward from Corps dumps by G.S. wagon, and the marshy ground caused awkward constructional problems.

Constant shelling added to the difficulties, and where all did splendid and gallant work it was difficult to pick out the finest. But for outstanding leadership, courage, and the inestimable quality of cheerfulness, two stood out—Lieut. W. G. Smith and Sapper C. B. Collier, who received the Military Cross and D.C.M. respectively.

Between the 6th and 23rd November, the 1st Division Field Companies took over the responsibility for all front line work east of Kronprinz Farm, and it will give some idea of the work involved when it is stated that in the Divisional area there were 35,000 yards of duckboard tracks to be maintained, requiring a daily supply of 1,000 duckboards for maintenance. Owing to transport difficulties fixing the position of R.E. dumps so far behind the line, sections very frequently covered 15 miles moving to and from work, carrying tools, and often duckboards, in the forward journey.

The utter misery of the conditions at this time are indescribable. The photograph of the Strombeek Valley gives some idea of the waterlogged waste. Soaked to the skin by the incessant rain, weighed down by equipment, tools, and the duckboard or what not for use on the work in hand, stumbling and dragging along the slippery slats on the narrow ridges between the shellholes, meandering sloughs hardly recognizable as paths, or digging, mauling, building in squalor and sludge, it was one long struggle of horror. Add to this physical effort the psychological effect of the dismal outlook, the waste of treeless, houseless, greenless landscape, destruction incarnate, the all-pervading smell of stagnant shellholes, with their frequently dreadful contents, and the ever-present expectation of a sudden "area shoot," a storm of high explosive and shrapnel breaking out at a moment's notice; and one marvels that any human being could live through such conditions and keep sane. But never for a moment did the splendid courage of the men fail; catching mirth from a mishap and laughter from the weariest work, matching depression with optimism, they won through, doing cheerfully and efficiently hour by hour, day by day, and week after week, deeds

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that, for the spirit which inspired them and the conditions over which the triumph was won, stand amongst the proudest in the history of the Corps.

On November 28th, the Company moved to rest camp at Proven, where it remained barely long enough to scrape off the accumulated mud, for on the 1st December it moved to La Minoterie, and on the 3rd to Paratonnerre Farm, taking over from a French *Cie du Génie*, the 1st Division having taken over from the French a line in front of Houthulst Forest.

On November 30th, Lieut. P. L. Forwood left the Company to join G.H.Q. Survey Company.

The work in the Houthulst sector consisted in screening Kortekeer Cabaret from direct observation, in pushing on the divisional tramline, and in maintenance of the Broenbeek bridges, the latter involving continual patrol and daily repair.

The tramline progressed at a fairly rapid rate, the figures being: Dec. 9th, 300 yards; Dec. 10th, 400 yards; Dec. 11th, 150 yards and 50 yards formation; Dec. 12th, 100 yards; Dec. 14th, 80 yards and 75 yards formation.

In addition, repairs were required to concrete pillboxes and also improvement in their limited amenities.

Christmas was spent in this area, and a good old-fashioned Christmas it was, with hard frost and deep snow. The Padre had mysteriously disappeared a few days before, returning with a real fine pig, which was, needless to say, an object of the greatest solicitude to the Company. History relates that one cold night, a loud squealing was heard about 1.0 a.m., which, on investigation by the C.S.M., proved to be a kind Sapper endeavouring to put a horse-rug round his prospective Christmas dinner. The thoughtful Padre had not forgotten that pig requires liquid assistance, with the result that all ranks had a festive evening, so much so that at a late hour the N.C.O.s' Mess turned out to sing carols round the officers' billets, four camps anything up to half a mile apart, through the snow. Their efforts were properly appreciated, Cowley getting an additional serenade. It was a tired, wet, but still cheerful party that turned in to bed about 4.0 a.m.

After this pleasant interlude work went on as usual. The frost was hard and prolonged, but whilst it lasted the consequent hardening of the muddied waste made it easier to get about off the duckboard tracks which were always an easy and popular mark for the enemy's artillery. Maintenance of the bridges over the Steenbeek and Broenbeek was an arduous daily task, culminating on January 16th in days of strenuous exertion, for a heavy storm following on prolonged frost and a sudden thaw caused the Steenbeek to rise 7 ft., a very serious matter in this low-lying and waterlogged area.

From January 24th to March 9th the Company was in reserve and

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working on the defences of the Army Battle zone, machine-gun emplacements, pillboxes and wiring.

On March 9th, work in the forward area was taken over from the 409th (Field) Company, in the Poelcappelle sector, the tasks being mainly wiring and shelters, later concentrating on strong posts for all-round fire in the support system of the forward zone; posts Bear, Eagle, Louis Farm, White Mill and Pheasant Farm.

Much of this work consisted of the construction of concrete pill-boxes, the value of which we had learnt from the enemy. Every effort was made to camouflage the work, for signs of new construction, whether shown by a gathering of tracks at a given spot or by signs of the work itself, the flat square of concrete or the regular hollow of the walls stood out at once on an aeroplane photograph in this bare waste of mud and shellholes. The management of tracks required great care, and the replacement of camouflage on completion of each night's work was most carefully attended to. In spite of this, working parties from time to time found that their efforts had been spotted by the enemy. One night, the 16th/17th March, Corporal G. Sims was in charge of a party of R.E. and attached infantry, working on a post, when the enemy suddenly opened heavy shell and machine-gun fire on the area, causing some dispersion of the party. This gallant N.C.O., however, got his men together again, and on to the work, until another burst of fire again stopped them. This happened two or three times, but each time Sims returned to the charge, a fine example of courage and leadership under difficult conditions which was deservedly recognized by the award of a Military Medal. Two nights later, a similar situation arose, but this time the shelling was so persistent and accurate that it was impossible to keep the party at work, and it was withdrawn. Nevertheless, Sapper R. W. Wade volunteered to return and replace the camouflage over the post, a task which he successfully completed, although the place was still being shelled. He, too, received the immediate reward of the Military Medal.

But the Sappers would be the first to admit that their efforts would have availed little had they not been ably backed up by the mounted section. The drivers' lot was a terribly hard one in this horrible battlefield. Moving up night after night with loads of stores on the crowded roads of slippery timber, constantly exposed to heavy shell-fire, horses and wagons sticking in the mud, and the stout-hearted, willing old "hairies" day by day showing signs of the long strain, it required the greatest skill and courage to keep the dumps supplied. One night in particular may be mentioned, when the route was heavily shelled. Lorries and wagons were in a jumbled mass, shells coming over at regular intervals were throwing up columns of mud and water over the road in the darkness, and horses became restive and difficult to control. Nevertheless, Corpl. C. H. Sole, by his

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example and quiet determined courage, kept his drivers and teams in hand, brought them safely through the turmoil in the darkness and duly delivered the goods, earning thereby his Military Medal as well as any honour received by the Company.

As the ground dried, it became possible on the higher ground to commence construction of mined dugouts, and to save the time, four hours, taken in marching up to the work and back to billets, sections lived on the work, increasing working hours to nine per day.

On the 21st March, the great German offensive in the South had commenced and as more and more Divisions began to go in that direction, rumours of a move became rife. In the words of the diary: "Rumour says we are going to nearly every place imaginable—quite a Cook's Tour, in fact." That a move was in prospect was a fact, for on the 7th April the Company turned its back on the Salient, and moving to Elverdinghe, Caestre (where old friendships were renewed) and Annezin, found its way once more to the old battle-ground of Cambrin.

Before leaving the Salient, a sad parting took place, for on a March evening the 23rd (Field) Company officers and others of the 1st D.E. gave a farewell dinner to "R.B.," nearly the last of the old "diehards" in the Division. Having commanded the Company from 1913 to the end of 1915, and having since then been C.R.E. of the Division, R.B. had served continuously with the Division in France for three and three-quarter years, and it must have been a deeply-felt breaking of the closest ties when the time arrived to say good-bye, though if rumour is correct the deeper feelings of regret were not allowed to spoil the festivities of the occasion. It was a great blow to R.B., who had aspired to see the War through with his old comrades, but in 1918 G.H.Q. ruled that officers who had served continuously in front line Divisions since 1914 were to be posted elsewhere for six months' rest.

It remains to note that, on March 15th, Capt. B. B. Edwardes, M.C., left the Company on transfer, 2nd-Lieut. E. T. G. Carter and 2nd-Lieut. J. C. Pocock joining the unit, whilst on April 1st, Lieut. W. G. Smith, M.C., was posted to the 26th (Field) Company as 2nd-in-Command.

(To be concluded.)

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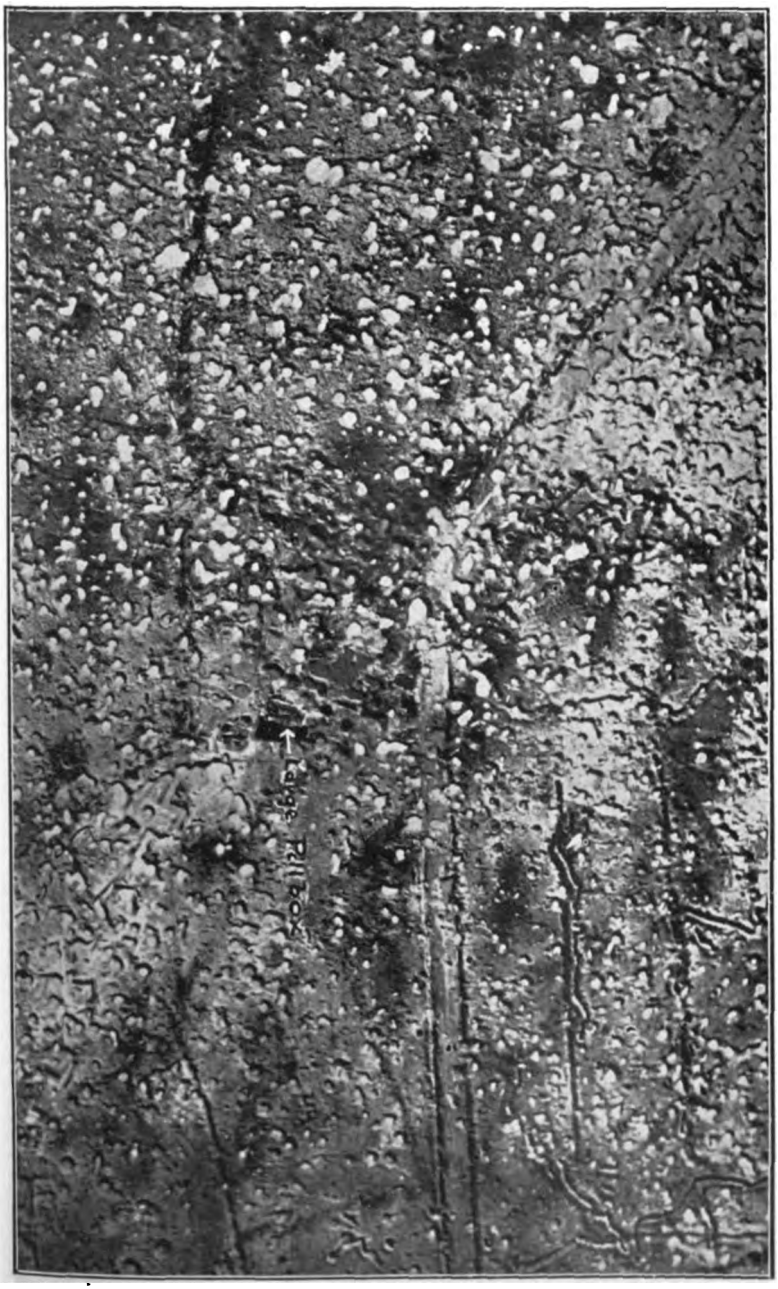
THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.



Strombeek Valley. November, 1917.

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WITH AN IMPROVISED A.C. COMPANY ON MANŒUVRES.

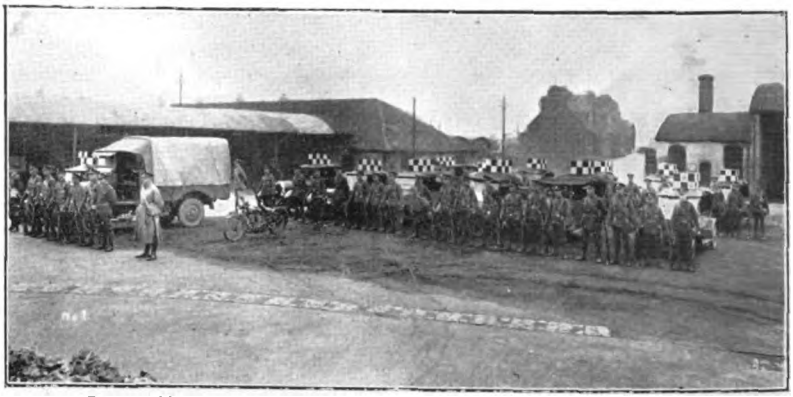

Photo No. 1.—A.C. Co. on parade before leaving Chatham.

Photo No. 2 Company H.Q. in Bures.

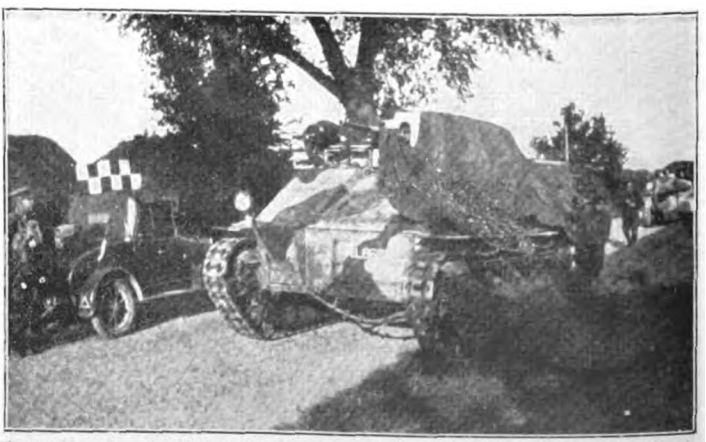

Photo No. 3.—At Force H.Q. on last day. H.Q. Car A.C. Co., Tanks moving into action and (behind) R/T Tender.

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WITH AN IMPROVISED A.C. COMPANY ON MANŒUVRES.

By " POL."

" No names—no pack drill."

INTRODUCTION.

IN the early part of 1928, enquiries were made by the Powers that Be as to whether Chatham could furnish an improvised Armoured Car Company, to take part in 4th Divisional Training.

Broadly speaking, the intention was to call for officer volunteers, using their own cars on a mileage allowance basis, to represent armoured cars.

Each car, according to seating capacity, was to have a crew composed of other ranks, armed with rifles, blank S.A.A., rattles, etc.

The Commandant, S.M.E., undertook to provide the " unit " complete, and volunteers were called for, officers under instruction being granted leave from their various courses during the period of the Command Scheme, in which alone the A.C. Coy. was required.

The required volunteers, with cars, were quickly forthcoming, and the scheme was launched.

FORMING UP.

On Saturday, 15th September, the Improvised Armoured Car Coy., R.E., formed up.

Officers, N.C.O.s and men paraded in the S.M.E. workshops yard at 9 a.m., the officers with their cars, and personnel and cars were allotted to sections.

Each fighting section of six cars (*vide* note on Organization at end) was sub-divided into three sub-sections of two cars, and, as far as possible, cars were allotted so that sub-sections were fairly balanced, one against the other, as regards seating capacity and power.

In each case, the Section Commander's " other half " was the smallest car in his section and was allotted the enviable job of " reconnaissance car," which in practice was apt to come down to the " sacrifice " to gain warning for the whole !

Personnel were then allotted to their individual cars and warned to learn definitely the appearance and numbers of their own vehicle.

Trial loading was then carried out, and " embussing " and " debussing " practised.

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The distinguishing marks were also fitted on to cars. These consisted of a light three-ply box, without top or bottom, fixed on top of the hood by divers and diverse methods of padding and lashing, all hoods being kept permanently up while "in action." The boxes measured 22½ in. square by 15 in. high, each face being painted in a black and white chequer, with 7½-in. squares.

This was found sufficiently definite to allow of no doubt on the part of units as to what the car represented, though it was felt to be somewhat of a handicap to a car trying to lie "doggo" in ambush.

No trouble was experienced with them, and two spares, taken along in case of eventualities, were not used.

The men were dismissed at 10.45, and a short conference of officers was held before lunch, at which the outline of the Command Scheme was discussed and a few principles as regards tactical handling of sections and sub-sections were laid down.

THE MOVE TO THE MANŒUVRE AREA (Sunday, 16th Sept.).

The Company's destination was Cockwatch Camp, Colchester, and the success of the move was felt to be largely dependent on the "unit transport" provided.

Two vans, one per section, were originally asked for, but this was found to be impracticable, and one 3-ton lorry was promised. The final allocation of transport by 4th Division gave us a 30-cwt. Crossley, and an emergency scale of loading for cars was, therefore, made out.

It was just as well, for when the fatal day arrived, the kit lorry which actually appeared turned out to be a 15-cwt. Guy.

N.C.O.s and men paraded at 9 a.m. with their kits, and the lorry was loaded.

Officers and cars paraded at 9.30, the Company in improvised formation of column of sections making quite an imposing though very definitely improvised unit, and personnel, at the emergency scale, "stood to their cars."

The "official" photographs followed, and at 10 a.m. the Company embussed and moved off as a formed body.

The start through Chatham and Rochester was a fairly high test of "march-discipline" to start off with, and was made no easier by the fact that the lorry, which started immediately behind the H.Q. car, so as to set the pace to that of the slowest vehicle, moved in low gear and very gingerly through the traffic.

Eventually, the Company got clear and halted at the top of Strood Hill, where the lorry was segregated and the driver told to follow in rear as fast as possible, in the hope that he would reach the ferry at Gravesend by the time the rest of the Company was aboard.

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We started again, moving at about 25 m.p.h., so as to reach the ferry up to time.

The lorry came, too, and refused to be shaken off so that when, after sending the D/R ahead, we reached Gravesend at 10.40, and found an empty ferry waiting for us, we embarked straight away as a single formed body.

From Tilbury to Brentwood, the column formation was kept, the lorry moving on its own in rear. Cars then proceeded individually, and at 12.55 all were present at the rendezvous at Mark's Tey. The Company entered Colchester as a formed body, and after taking one wrong turning, which proved to be a dead-end and provided some excellent turning practice, halted in " column of sections " in Cockwatch Camp at 1.20 p.m.

The lorry arrived at about 2.15.

Two incidents of the journey recur to the mind, sufficiently trivial to show that, mechanically speaking, it was without incident.

At one small wayside pub., the name and location of which cannot, for obvious reasons, appear, the request for beer was met by an offer of tea. Watches were consulted and we realized the worst. A request for really nice strong tea—in a glass—was, however, more successful, and the secrecy of our potations went only to improve an excellent sample of the national beverage.

Essex accepted us fearlessly, to the credit of its inhabitants, but speculation was rife as to the purpose of our chequered " turrets," and we got no small amusement from such conjectures as we overheard.

" Camouflage " was heard more than once, but the palm for apt retort goes to a cycling club, overtaken on the journey up.

Every motorist will understand the arising of a swift though brief conversation.

They won—the leader, disdaining that more usual suggestion, requesting us to " go home and play draughts with yourselves."

In view of our conspicuous " label," there was no reply to give.

At Cockwatch Camp, the O.R. were soon comfortably settled, the 1st Bn. Argyll and Sutherland Highlanders being responsible for their rations and accommodation throughout our stay in the area.

Officers sorted themselves out among the Colchester hotels and, after a short conference at 3 p.m., they all went out to reconnoitre the southern half of the scheme area in preparation for the " war " next day.

Our arrival was reported to O.C. Skeleton Enemy, under whose command we were, orders were received for our move out to the ground next day and a warning order issued to the men, who reported " all comfortable and food good."

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THE FIRST DAY.

Operations were timed to start at 5.30 p.m., and the morning was spent in further reconnaissance on the part of all section officers.

This previous reconnaissance, which was fairly thorough, perhaps made the " war " somewhat unreal, as every driver was able to get a fair idea of the area he was likely to work over before " war " was declared, but as it was vital to the success of the scheme that the Company should function efficiently in the various stages in which it was engaged, and as, in addition, the country was particularly close and blind, it was considered essential rather than as merely admissible.

While the section officers were quite legitimately running up their mileage claims, Headquarters received a variety of set-backs from the Administrative point of view.

The most serious one was that the rattles, which had been indented for some time previously and on which we depended to a large extent for the realism of our show, had not arrived. In the course of a hectic hour, copies of indents, vouchers, advice notes, way-bills and the whole glorious paraphernalia required to get ordnance stores out of their permanent abode and into a " unit's " possession (on temporary loan and *via* a private railway company) came to light, but the bitter fact remained that no rattles had arrived. Attempts to borrow from units proved abortive, each unit having, quite rightly, determined that its Lewis guns should receive due credit. So the A.C. Coy. went without.

A further disappointment was in store.

One of our jobs was to raid the enemy outpost line at night, with the sole purpose of keeping the weary soldier awake. Our nefarious purpose, previously blessed with official approval, was to shoot off Verey lights from a comparatively safe distance and at intervals during the night, over a fairly wide front. The juxtaposition of a vigilant compensation staff and a number of haystacks and other inflammable materials, however, negatived this proposal, and our night raid became, in consequence, a totally different proposition.

Eventually, however, available stores (consisting, in fact, of a large quantity of blank S.A.A. and six large white flags) were drawn, definite timings for the phases of the day's operations were received and, after yet another of those inevitable conferences, without which it appears impossible to " manœuvre " adequately, the Company was ready to move off.

At 1400 hours (how subtly do we indicate the start of war), we paraded and left Cockwatch Camp in column of route, moving to the inn at Fordstreet.

Apart from having to overtake a travelling circus on the way, the

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move was without incident. On arrival, blank S.A.A. was issued and we sat down to await operation orders and the umpires.

Both arrived at 1500, and verbal orders for Phase A1 (driving in of cavalry and reconnaissance for the enemy outpost line) were issued at 1645, after considerable discussion as to how the umpires were to work, as the Company cars could not transport them and the keeping of touch otherwise was bound to be difficult.

It is not proposed to go at length into the scheme. Suffice it to say that the 4th Division was advancing northwards, with an imaginary Division on either flank, opposed by a Skeleton Enemy, whose intelligence was, of necessity, amazingly good!

Thus, we knew at the outset that the Southland Corps, of which 4th Division was the centre, had issued orders to halt for the night, that its cavalry had reached the line of the Colchester-Braintree road and was about to withdraw behind the outpost line.

Phase A1.

The frontage was divided into two sectors, roughly as shown on sketch map; No. 1 Section right, No. 2 left. Coy. H.Q.—Inn at Fordstreet.

A time-table of bounds was given and at 1730 hours, both sections crossed the River Colne.

Coy. Headquarters got itself under cover and sat down to await eventualities, watching a C/R machine working along the line of the river, and wondering where the infantry, whose orders were "to occupy the crossings of the R. Colne," had got to.

At 1820, a message was received from No. 2 Section, timed 1804, stating: "Have secured line of main road. Met slight opposition. Am proceeding to Copford."

Headquarters then moved forward to Aldham, and the D/R was sent out to locate No. 1 Section.

Shortly afterwards, a car from No. 1 arrived with a report of lurid battle, as a result of which the other car of the sub-section had been put "out of action." Section Headquarters had disappeared and the situation on the right was distinctly obscure.

Here the inadequacy of our communications was immediately shown. Single cars received short shrift from umpires and sub-sections could not communicate with Section Commanders, nor Section Commanders with Coy. H.Q. without detaching fighting cars. The story of the day emerged at a conference when the Company reassembled after dark.

An intermediate, untimed bound, running east and west through Aldham was, as anticipated, reached without incident. The object of this line was merely to get sub-sections disposed over the frontage to ensure that all roads running north and south were patrolled.

To take the right sector first.

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A theoretical harrow and some real cavalry were encountered at Little Tey House, but the cars were judged to have pushed them back and were subjected merely to a short delay, for the purpose of removing the obstacle.

The main road, forming the first main bound, was reached on time and found to be clear.

South of it, however, a great battle developed, particularly on the right.

A well-sited anti-tank gun fairly early accounted for one car at Langley Green, but the second car of the sub-section was allowed to have dealt firmly with the gun and crew. This car was then badly chivvied. Proceeding southwards, it spotted a second A/T gun, turned and tried to get out by Old Wills Farm. There further cavalry were found, so the driver made a dash back, passed the located gun at speed, turned right past the Warrens (there taking an A/T gun in reverse), and so returned to safety, having located enemy troops at five points. After reporting to Coy. H.Q., he returned and was shortly afterwards put out of action by an umpire who had got tired of his depredations.

Another car from No. 1 Section got through Easthorpe, where cavalry were shot up, and went south to Messing. This village was found to be full of enemy infantry, who were bivouacking there, and the car most unsportingly disturbed the weary "feet" who were fraternizing with the local youth and beauty, by driving through the village at high speed, with its crew deliriously getting off blank in a valiant endeavour to reproduce the effect of machine-gun fire.

A definite identification was obtained here, and the car, having penetrated the outpost line, was in some miraculous way allowed to get home again *via* the main Witham-Mark's Tey Road.

No. 2 Section, on the left, first met enemy cavalry at Mark's Tey Station, and then located them at seven or eight points in the area south of Copford. The umpires dealt rather harshly with the A.C.s in this Sector, but one car from this Section also got into the outpost line, and obtained an infantry identification at Smyth's Green.

It was disturbing to find that the umpires had put out of action no less than nine of the twelve fighting cars, but the job had been done in the face of some difficulty.

Two things contributed to make this bit of war unreal and unnecessarily difficult.

Barriers, in practice, take time to assemble, and are usually visible unless very cunningly sited.

Even a harrow in the road is likely to be spotted in time to pull up and reverse if necessary, for an A.C. cannot crash blindly along in enclosed country. A piece of paper on an overhanging branch, backed by an umpire stepping out from behind a bush at the critical moment, is a poor substitute.

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The green flag with a white cross is a readily recognizable symbol for an A/T gun, but its concealment in a pocket is more complete than that of the actual gun and crew are ever likely to be. It was felt that in some cases, at all events, the armoured cars were hardly dealt with, and in one particular case, where the green flag was produced out of the pocket of a gentleman who had just arrived on horseback, the car-driver, very rightly, " took a life " in defiance of all argument.

Thus ended Phase A1, and the dead cars came to life again.

Phase A2.

The next item on the programme was the raiding of enemy outposts.

As previously stated, the original scheme had been considerably modified, and it was subsequently decided that one section only should carry out a raid on one selected locality.

As a result of the information obtained by the evening's reconnaissance, the point selected was Smyth's Green. Messing was not considered so suitable as, firstly, there was but one road leading into the enemy's position there and, secondly, although the village was known to be full of infantry, the location of the outposts was unknown, as they were apparently not in position when the armoured car passed through earlier in the evening. The Easthorpe-Messing road is also very narrow and enclosed by high hedges and winds and twists considerably, so that its use at night would have been very risky. The raid, therefore, fell to the lot of No. 2 Section.

It had been decided that one section should be on duty at two hours' notice throughout operations. This meant that officers and their cars had to remain at Coy. H.Q., as time was necessary to pick up O.R., so that the section on duty could not count on finding a comfortable pub. in which to spend their sleeping hours.

No. 2 lost the toss and so had a night out after the raid.

No. 1 Section then departed to find beer and beds, while No. 2 made arrangements for the forthcoming raid, which was timed for 2300.

Company Headquarters remained at Fordstreet, and at 2220 hours, No. 2 left for Copford, on which the actual raid was to be based, accompanied by the D/R, loaned for the operation.

The raid was, apparently, a success, although two cars were put out of action. It is thought that the leading (reconnaissance) car got through too far before being spotted and was then unable to get back, while the second car was bagged by an A/T gun, which was probably produced in a hurry from somebody's pocket in honour of the occasion.

What was really supposed to have happened will probably never be known (though one sub-section sent by an alternative route,

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arrived in the nick of time, from the opposite direction!)—in actual fact, there was considerable argument, mainly noisy, between all parties concerned, including the unfortunate umpire detailed for the job.

Honour was apparently satisfied by balancing an entire picket, with sentry-groups and A/T gun complete, against two cars, though one car only saved its draught-board " turret " with some difficulty, an infantry officer being particularly anxious to obtain it as a souvenir of the occasion.

History does not definitely relate whether the driver *did* help him to finish the bottle or not.

The completion of the raid was reported at 2330 to Coy. H.Q., which withdrew at 2345 to a pin-point, where was H.Q. of the Battalion to which the Coy. O.R. were attached.

No. 2 Section arrived there at 0040 hours, having unfortunately listened to a Highlander who was thought to have said, in his own tongue: " Straight down the road. You can't miss it." There was, of course, the inevitable fork, and they did miss it, but fortunately only once.

In all, nine officers " slept " in their cars, the remainder found an excellent inn in Bures, which was promptly marked down as a future Coy. H.Q.

During this raid, the first real casualty occurred. One of No. 1 Section's cars, after dropping the crew at Battalion H.Q., was looking for a night's lodging and was involved in a purely civilian accident on the main road.

The telegraph pole won and the car was a casualty for the rest of manœuvres, though its owner most sportingly turned up in a truly marvellous hired barouche on the third and fourth days.

THE SECOND DAY.

Phase B.

Phase B was practically the reverse of Phase A.

The 4th Division, preceded by cavalry, advanced northwards, while the A.C. Coy. fought a delaying action back to the line of the River Colne, which was held by our infantry.

Tea was issued to the men at 0500 hours by the Battalion, who never failed to do their utmost for our comfort.

The company formed up by sections in column of route and moved off, No. 2 at 0515, No. 1 at 0525, with orders to secure the main Colchester-Braintree road. Both sections crossed the River at 0545, No. 1 at Wakes Colne, No. 2 at Fordstreet, and reached their objective without incident, no enemy being sighted till 0700 hours.

Very full information was sent in once contact had been gained,

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and there can be no doubt that the cavalry were seriously delayed and would have suffered very heavy casualties.

The experiences of the previous day had made a big difference in the handling of the cars, everybody now knew what to expect, and with the change-over of functions between cavalry and cars, the boot was on the other leg.

Great difficulty had been anticipated, owing to the enclosed nature of the country, and everyone had been warned to look out for cavalry working round behind sub-sections and blocking the roads behind them.

By working sub-sections in depth, however, this was overcome, and no cavalry succeeded in getting past the cars.

The main road proved a tremendous obstacle to the unfortunate mounted men, for its long, straight, wide stretches gave the cars a wonderful field of fire, and they were able to cruise up and down and totally deny its passage. There appeared to be no artillery fire on the road to help them, and they could not get their A/T guns forward, as the umpires were now very stringent as regards their vulnerability on the move.

On our extreme right, patrols did succeed in working across, and it was subsequently found that the maps on either side differed entirely as regards the western boundary, beyond which movement and fighting was taboo.

In due course, the Company withdrew, " according to plan," and the fun started.

Two methods were employed. In the first, the leading cavalryman was shot as he came round a corner. Bearing the charmed life of manœuvres, he promptly galloped away and gave the alarm. The troop leader made his plan, put it into execution, and—found the quarry gone. Two hundred yards further back, the game began again. The delay caused was simply marvellous and the cavalry must have hated it.

The second method was more subtle.

The " advance guard," or " point," was not shot. He was merely very firmly, but in complete silence, stopped and removed from his horse as he came round the corner.

The troop followed, having no alarm given this time, and either the whole or the greater part was shot up from the car. The umpires always let one man get away to give the sorry news and, by the time a new troop came up, the ambush had gone once more and the game began again.

In accordance with orders, the sections withdrew over the Colne at 0910 and 0915 respectively, though it seemed a pity to have to leave the game unfinished. The bridges were " blown " and the infantry took on the war.

Casualties to cars—*nil.*

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The Company was not scheduled to appear again till the next (third) day, so the men were returned to their bivouac of the previous night. Coy. H.Q. and No. 2 Section (on duty) repaired to an excellent inn at Bures and the officers of No. 1 retired to Colchester and elsewhere for the day.

The men moved about one and a half miles by march route, with Bn. H.Q. when they moved back at 1730 hours.

In the evening, orders were received that the Coy. would form part of a rearguard next day—the O.C. Rearguard being the C.O. of the Cavalry Regt., against whom we had so far been in action, and who changed sides at this stage, their *rôle* with the Division being now at an end.

THE THIRD DAY.

While the Company had been out of action and in reserve, the infantry of the Skeleton Enemy had been pushed back from the line of the R. Colne to a line running roughly east and west through Beak Farm and Jenkins Farm, known as Line D.

The further retirement, back to the River Stour, was not easy owing to the shape of the ground, and it was decided to effect this under cover of a counter-attack by the tanks, after which the enemy would be delayed by a rearguard, composed of the Cavalry Regt. and Armoured Car Coy., until such time as infantry positions about the Stour could be taken up and the new line of defence organized.

O.C. Rearguard held a conference at 1000 hours and issued his orders for the conduct of the operation, which, in fact, was in some ways the most interesting and instructive part of the scheme from the point of view of the Company.

The main idea was to form, as it were, a line of mobile forts, each consisting in fact of a sub-section of A.C.s, with a troop of Cavalry.

This involved the temporary reorganization of the Company. One sub-section was withdrawn from each Section, and Nos. 1 and 2 Sections were placed under the command of Cavalry Squadron Commanders.

The two sub-sections withdrawn were formed into a temporary No. 3 Section, which, with Coy. H.Q., was retained as a reserve under the hand of O.C. Rearguard.

The leading sub-sections were allotted one to each of four important roads, and were disposed in depth, each having its troop of cavalry to fill gaps and carry out scouting and patrolling duties. The principle was a modification of that adopted for the delaying action of the second day, and was completely successful.

The reserve, unfortunately, was used piecemeal, and its power of counter-attack was thereby wasted.

One car was first taken to replace one of those of No. 1 Section, which had been put out of action for two hours. Then a sub-section

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was removed on a special mission, leaving one fighting car and the H.Q. car in reserve. These two were asked to form a fighting sub-section, which was promptly done, and shortly afterwards the longed-for counter-attack was launched on the initiative of O.C. Sub-section, *alias* O.C. Coy.

This was, perhaps, quite wrong, but, as the D/R had been taken by O.C. Rearguard for his own use, and there was, in consequence, no news or knowledge of what was going on, the sight of a number of tin-hats, just over the crest behind which the reserve was located, was too tempting.

The counter-attack was very successful.

The tin-hats seen were found to be already " dead " or " captured," having been accounted for by one of No. 2 Section, but further down the road two companies, with transport and in column of route, were very completely shot up.

A/T gun flags were, however, rapidly produced as the cars passed, and it was judged impossible to attempt to return the same way.

Turning right, more troops were caught " on the hop," the best of the bag being a Battalion Headquarters and two " brass-hats," who were having lunch. One of the Directing Staff put them out of action, but his car, which was completely blocking the lane, was a most unfair obstacle. The delay and noise gave ample warning and, on proceeding, the leading car took two rounds of blank from a field-gun at about four yards' range, fortunately without actual damage to car or crew.

There being no umpires, however, the sub-section completed its circuit and returned to reserve.

The fog of war now descended and it was here that the greatest training value was received. No. 2 Section, on the left, had a straightforward task in getting back across the Stour at Smallbridge, but No. 1, on the right, was left to its own devices while its cavalry retired across country, and No. 3, hopelessly split up, had no orders for the future at all.

Retirement *via* Bures involved an awkward move across the front, in which two sub-sections helped back a troop, finding many " advanced elements " of enemy infantry across the road on the way.

Arrived in Bures, No. 3 miraculously materialized complete, and was sent out again to Brook House (about half a mile south of the river), with definite instructions for an independent *rôle*, as all the cavalry seemed to have disappeared. No. 1 also collected, were given definite orders, and sent out to Mount Bures.

Eventually, orders were received to retire across the river, O.C. Rearguard released the Coy. from his command and returned the D/R, No. 2 Section arrived and the Coy. moved back to bivouac at about 1800 hours.

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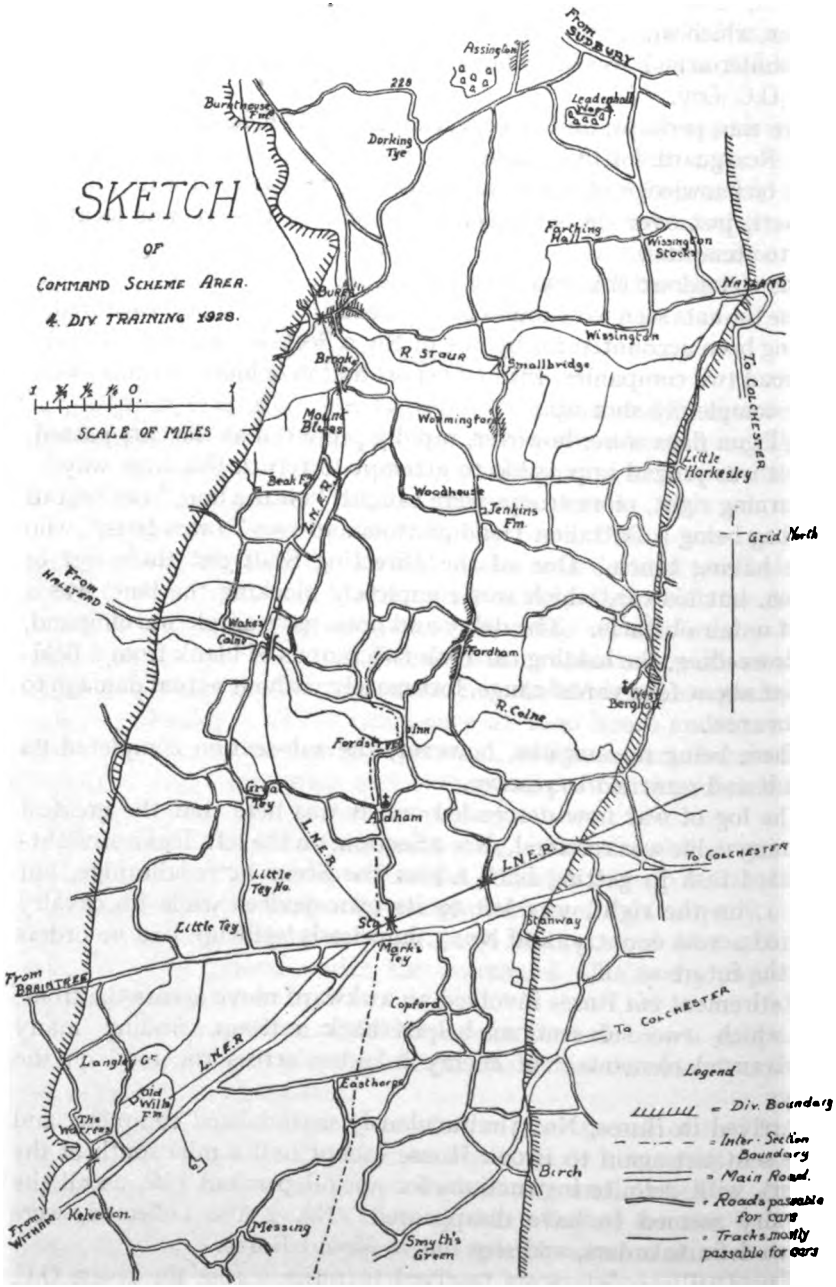

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The O.R. rejoined Battalion H.Q., now at Wood Hall, from which they had subsequently to move about three miles by march route, and officers and H.Q. repaired to Assington.

During the day, one car had been put "out of action," and two actual casualties were sustained.

One car, in turning in a very narrow lane to get away from an A/T gun, got ditched and broke a torque tube, putting it definitely out of action for the rest of manœuvres, and another, taking a corner rather fast on the way "home," skidded on the appallingly bad surface, burst two tyres and upset, slightly buckling one wheel, but without damage to personnel, except for one bleeding nose.

The Fourth Day.

H.Q. and No. 1 Section (on duty) spent the night at the inn at Assington, after a musical evening provided by the landlord's wife and daughter, who also produced most substantial haversack rations at 0430 next morning, and filled all the thermos flasks available in the Company.

O.R. had been warned overnight to be prepared to move at 0515, and the Company paraded at men's bivouacs at 0530.

No. 2 Section were sent out to the right to the vicinity of Bures (held by the cavalry) to fight a delaying action along the two roads running northwards from Bures, with orders not to become seriously involved but to withdraw to the road running east from Burnthouse Farm, and create an "impasse" on that line.

No. 1 Section were ordered to form a similar "impasse" along a portion of the Nayland-Sudbury Road, and Coy. H.Q. formed a "block" at a centrally situated road junction.

The idea of this plan was to force the attacking Division forward into a sort of arrow-head towards Assington and, at the psychological moment, to launch a counter-attack with tanks and infantry from the vicinity of Leadenhall Wood. To make this counter-attack reasonably heavy and realistic, practically all infantry had been withdrawn from the line, so that the Division were more or less unopposed except by the "impasse" of cavalry and armoured cars, and the counter-attack was launched by two battalions nearly at full (manœuvre) strength.

No. 2 fought a very successful action on the right and, by occasional dashes into Bures, seems to have prevented any effectual attempt at crossing the Stour there in any force.

One battalion, however, did get across further east, and the Section was able to help the cavalry whose left had been threatened thereby.

No. 1 had a very dull morning and did not come into action.

Headquarters had, probably, the most instructive morning, during which several quite interesting photographs were obtained, the

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opportunity for getting which is perhaps best explained by a bald extract from the Company log:

"Was instructed to attend conference at Force H.Q. at Y9847 at 0800. At that hour H.Q. was represented solely by R/T Tender.

Col. C— (*O.C. Skeleton Enemy, telegraphic address 'Bones'*) arrived later and gave me zero-hour for counter-attack as 0845 instead of 1130.

Lorry had been adorned with (spare) Distinguishing Mark to represent A.C. road-block at Y8859.

H.Q. Car was neutralized and asked to pick up Col. C— on 1st objective.

Got car to Farthing Hall, Y9536, in time to find counter-attack checked on right and enemy F.A. Section in action in hedge just west of Farthing Hall. A car from No. 1 had followed H.Q. car up from Wissington Stocks and got fire in partial reverse on gun crews, who were rushed and captured by 91st two minutes later.

Sent car back to normal *rôle* and moved down to Y9725 (on second objective), where good view of tank action was obtained.

Cease fire went shortly after."

The Company returned to Colchester by sections under orders given previously. O.R. were taken back to Cockwatch Camp, the remaining blank S.A.A., empties and white flags were handed over, two conferences attended and a warning order issued for the return to Chatham next day.

THE RETURN TO CHATHAM.

The Coy. paraded at 0800 and moved off at 0815, moving as a formed body to Mark's Tey and thence individually to a rendezvous just outside Tilbury, at 1020. The ferry was reached at 1035, and the Company crossed at once, moving from Gravesend to Chatham as a unit, and forming up in S.M.E. workshops yard on arrival.

The Acting-Commandant and the Brigade Major inspected officers and men shortly afterwards, and disbandment of the Company was completed by 12 noon.

CONCLUSION.

General Remarks and Lessons Learned.

The organization of the unit and the administrative arrangements made proved very satisfactory. As regards the domestic provision for O.R., we were undoubtedly very lucky in being allotted to the particular battalion selected.

They at all times did everything possible to ensure the comfort of our N.C.O.s and men, and it is doubtful whether any future improvised unit could count upon being as well looked after as we were in this respect.

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The main flaw in organization was the difficulty of communication. From the experience gained, it is considered that a minimum of 1 D/R for Coy. H.Q. and 1 D/R *per section*, should be provided. This would ensure proper co-operation and a fuller and more timely flow of information.

Perhaps the most noticeable feature of the short period of training was the difference in control and initiative brought about in all ranks. From this point of view, at all events, the training received was of great value, even if the tactical " lessons " may be open to more doubt.

At the outset, the majority of the young officers were, as was only natural, not quite sure what they were up against ; but in a very short time, measurable almost in hours rather than days, they had all gained a little experience and considerable self-confidence, with the result that tactical handling, initiative and power of quick decision were improved out of all knowledge. N.C.O.s and men also quickly adapted themselves to an entirely new set of conditions (the men, it must be remembered, were all recruits) and were invariably cheerful and resourceful.

The tactical lessons learned can, of course, only be put forward with some diffidence.

Manœuvres and war are very different propositions and, however good the umpiring, a makeshift unit of this kind can in no way adequately represent the real thing in war.

The outstanding lesson appeared to be that, particularly in enclosed country with narrow roads confined between banks and hedges, the lot of the armoured car advancing or reconnoitring against a mobile enemy, who disposes and utilizes his A/T weapons adequately, is by no means a happy one. On the other hand, their value in delaying action appears tremendous, especially if one can assume that the A/T weapon is likely to be big and cumbersome and require a fair-sized crew. It would, in fact, appear essential to provide a mechanized and probably armoured weapon to enable infantry or cavalry to get forward against a screen of armoured cars without fearful delay and waste of time and lives.

The value of co-operation between armoured cars and cavalry in delaying or rearguard action was clearly brought out.

Finally, there is no doubt that really excellent weather, such as was experienced throughout the scheme, is the main factor in making manœuvres an enjoyable proceeding.

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APPENDIX "A."

ORGANIZATION.

Thirteen officers with cars were originally authorized, *i.e.*, O.C. and 12 fighting vehicles, and "A" Company of the Training Battalion offered a complete Recruit Party, due to pass out a day or two before the start of the Command Scheme, with a proportion of N.C.O.s.

After some preliminary office work and correspondence the organization decided upon was as follows:

Headquarters.

2 Officers, 2 N.C.O.s, 3 Sappers.
1 car, 1 motor-bicycle, 1 light lorry.

2 *Fighting Sections.*

Each:
6 Officers, 1 N.C.O., 12 Sappers.
6 cars (4 four-seaters and 2 two-seaters).

Total Strength of Unit.

Officers	14
N.C.O.s	4
Sappers	27
Cars	13
Motor-bicycle	1
Light lorry	1

The extra officer and motor-bicycle were approved for D/R purposes, for inter-communication and liaison generally.

The light lorry was supplied by 4th Division to carry men's kits and bedding, unit stores, etc.

It will be noticed that the organization adopted makes no attempt to follow that of the genuine Armoured Car Company. This was done deliberately, for the following reasons:

(1) The unit formed part of the Skeleton Enemy, and its *rôle* in every phase of the scheme was, therefore, accurately known in advance.

(2) The Skeleton Enemy kept no reserves in hand.

Each unit represented only the "front-line" troops of the enemy force, reserves and reliefs being purely imaginary.

(3) The ground lent itself more readily to division into two fairly wide sectors than into three.

(4) Apart from the O.C. Unit, only two officers had completed their Y.O. course at Chatham, and it was felt that Section Commanders should have rather more experience than an officer under instruction could reasonably be expected to possess.

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APPENDIX "B."

ADMINISTRATION.

The administrative problems involved were a source of a good deal of trouble and preliminary work, but, owing to the very helpful co-operation of all those in authority, were satisfactorily solved before the unit formed up.

Officers were granted Detention allowance and Mileage allowance while in the manœuvre area, as it was impossible to organize a mess, and kit, etc., had necessarily to be reduced to a minimum.

They, therefore, made their own arrangements and were, in fact, very well looked after and catered for by the country inns in the area.

Other ranks were attached for rations, etc., to one of the two battalions, forming part of the Skeleton Enemy, and were made welcome and comfortable by the 1st Bn. Argyll and Sutherland Highlanders.

Steel helmets, packs and bayonets were not taken on manœuvres, as they were not required, and would have been an encumbrance in the cars.

Each N.C.O. and sapper carried the "pack" scale of clothing and necessaries in his haversack, and carried a waterproof sheet (cape), while the following kit per man was carried in unit transport:

3 blankets.
1 waterproof sheet (making two in all for bivouac purposes).
Greatcoat.
Kit-bag with change of clothing.

Notes on Organization and Employment and *Administrative Instructions* were issued to all officers and N.C.O.s, and, after two conferences had been attended at Colchester, at which tactical and administrative details were finally settled, the unit existed on paper and was ready to come into actual being.

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PSYCHOLOGY AND THE FIGHTING SERVICES.

A Lecture delivered at the S.M.E., Chatham, on 7th February, 1929, *by* F. C. BARTLETT, Esq., M.A.

VERY briefly and simply, psychology is a sustained attempt to find out why people act as they do. For various reasons, this attempt seems to meet with much opposition. Some people think that it lowers the dignity of human nature, for there is, they say, in all our activity, something completely incalculable and out of control. But these people are just as annoyed as the most ardent psychologist if they are called fickle and unreliable, and the success of innumerable forms of organized human effort makes it perfectly certain that, provided people are given fairly stable conditions, they will act in a tolerably uniform manner. Other critics at once assert that human conduct is too complex to be studied successfully with this aim in view. But instead of arguing at length whether or not this is a fatal stumbling-block, it seems better to see what the psychologist, who is himself most ready to admit the complexity of his subject matter, can do before insisting that he cannot do it. At least, it is obvious that if the psychologist can successfully find out important truths about why people act as they do, this knowledge must be useful in any practical organization of human conduct. This is now coming to be widely admitted, and it is upon this that the importance of psychology to the efficiency of the fighting services rests.

In every age, the main business of an army is to be ready to fight, and to be ready to fight well. There is no dispute about that. But fighting in these days is a very different matter from what it was when standing armies were first raised. It now rests largely upon the co-ordinated and harmonious operation of a vast mass of highly-skilled and highly-technical activities. Every one of these activities depends upon some special ability, or some group of special abilities, which must be trained to the highest possible pitch of efficiency. If all these abilities, or capacities, were showered upon all of us equally at birth, the matter would be comparatively simple. We could take in recruits haphazard to the Navy, the Army, or the Air Force, send them wherever there were vacancies and, if the training were good enough, be sure of arriving at a satisfactory result. Everybody who has had even a small amount of practical experience knows that this is not the case. The first-class fighting pilot may make a bad infantry officer. The Tank expert may be of little use in an intelligence department. Signalling demands different capacities from those required in artillery or gunnery. Hundreds of training courses, most

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of them making particular demands upon some special executive skill, are needed to develop the modern fighting force. It is not a matter of indifference how people are distributed around these courses and sent eventually to their own main arm of the service. The actual training given may be as good as it can possibly be, but as a man moves from one course to another the speed of his learning and the efficiency of his final performance are bound to vary. As it is, we pay little attention to this obvious fact. A man may go into a signalling service whose speed of response to auditory or visual signals is slower than the normal, whose immediate memory span is small, whose capacity for delicately-adjusted manual movement is slight. He may enter some branch of mechanical transport and turn out to have a mechanical mind only so far as the *understanding* of the construction of his mechanisms goes, and not for their *practical* manipulation. He may be trained as a gunner, though he has some slight but readily detectable defect of binocular vision, or a lack of co-ordination between visual and manual response. He may go through an expensive course of training in musketry, though he has a marked left eye predominance. With a strong social trend, he may be given a job demanding individual initiative above everything else, or, with any amount of individual initiative and little social sentiment, he may be pushed into team work. In all these cases and in very many more, the training will go against the grain, and, however good it may be in itself, it must fail to produce the efficiency that is desired and that is possible, because it has not got the best material to work upon.

A great amount of this training is expensive. It may take £200, £300, £400, to produce a reasonably trained man for a technical branch of a fighting force, even if the rank and file alone are considered, and much more in the case of many officers. I wish it were possible to know exactly how many men, trained in these ways, turn out each year to be relatively inefficient. Many of the failures are eventually got rid of; many more remain to put the general standard low or to become permanent and dangerous centres of discontent.

This is one of the things which the psychologist wants to alter. Even if he can do only a little towards setting the matter right, it is worth while. The cost of a few efficient psychologists would be far less than the cost of a lot of inefficient soldiers, sailors and airmen. And cost in money is only a very small part of the matter. The psychologist's proposal is simple commonsense. He says that, before the would-be fighting man is given his special training, we ought to know something more about him than that he has a fit physical frame and at least a minimum of intelligence. We ought to find out the sorts of things that body can best do, the directions in which that intelligence can most efficiently turn. If we know this, and if we know what bodily and mental skills a particular arm of the service makes most demand upon, we can then direct him towards the kind

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of fighting for which he is naturally most gifted. The modern fighting force is big enough and varied enough to take every fit man and put him where his special fitness will have the best chance.

It is of little use to discuss these proposals in general terms. I will take one or two illustrations, though here they can be worked out only in scanty detail. Defence against attacking aeroplanes consists largely in the co-ordinated operation of aircraft detection groups, defence aeroplanes and, at night, searchlights. Aircraft detection is a very complex business, but at present it makes use of certain powers which the human ear possesses in picking up, recognizing and localizing sounds of a certain pitch, quality and rhythm. Some men can be trained to be good listeners with comparatively little effort, some with greater effort, some not at all. Now it is demonstrably possible to take a group of men, and, by putting them all through certain simple but special tests, to predict how they will behave when their ears have to solve the kind of problem which the detection of aircraft demands. This was actually done in various ways and with much success during the War, but the lessons of a war are speedily forgotten, and much that was then learned was later allowed to disappear once more.

Take signalling also. There are, of course, many different ways in which this must be carried out. Each way has its basis in some simple group of bodily and mental capacities: swift auditory or visual reaction; the power of readily grouping symbols which vary slightly in form, number, length, colour, or some other assignable character; in transmission, a capacity for delicately-graded and accurate control of finger, hand and arm movements. The experimental psychologist has devised readily applicable tests for all of these, and again it is demonstrable that a group selected on the basis of test records contains fewer potential failures than a group of the same size selected merely on the basis of a written examination of some kind, a simple medical test and an interview.

Working for the Industrial Fatigue Research Board, under the general direction of the Medical Research Council, Farmer and Chambers have very extensively applied a battery of about nine tests of mental, manual, muscular and co-ordinated dexterities to aircraft apprentices. The results show definitely that the tests are a more efficient instrument of selection for this sort of work than any of the other methods now in use. A similar research is proceeding in connection with naval gunnery, with the same promise.

Finally, let us take so simple and basic a performance as shooting with a rifle. For the past eighteen months or so, we have been trying, in the Cambridge Psychological Laboratory, to find definitely the conditions of good marksmanship so far as these reside in the marksman himself. Keenness of vision, the only thing that is now specifically tested, is relatively unimportant. Dominant right eyedness is essential for obvious reasons, though it is never officially

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considered. The evidence is accumulating that the rest is mainly a matter of certain simple kinds of muscular control—visual control and hand, shoulder and arm control—and of a certain temperamental constitution. For all of these it will soon be possible to have definite and easy tests by means of which probable duds can be straightaway eliminated and time, money and temper saved.

Much more than I can even hint at has been done, but far more yet remains to do. Some of the most important questions of selection demand a different type of psychological observation. Take the very interesting problem of the difference between the typical field-and the typical staff-officer. The former is the man of action, of social tendencies, never really happy unless he is in close touch with men, the executive type. The latter is the man of schemes, often rather aloof from personal contacts, interested in trying to see things as a whole, rather than in trying to carry out things in part. The difference between the man fundamentally interested in life and the man mainly interested in schemes, in things and their inter-relations, is a tremendously deep-seated one and probably innate. Give either the work of the other and he will be unhappy, very often relatively inefficient. Questions of just the same character, differing according to the groups concerned and the tasks set, arise in all choice of non-commissioned officers. At bottom, all of these matters are psychological. They depend (1) upon knowing what conditions make people do certain things, (2) upon knowing what sorts of things certain tasks demand that people should do, and (3) upon bringing together these two sets of knowledge, so as to make as sure as possible in practice that the people who can do certain things under the given conditions shall have the chance to do them.

I had better make it quite clear that no sane psychologist ever claims that in this matter of selection he can proceed without mistake. His methods may let through some bad individuals and keep out some good ones. But it has been proved again and again that, in groups of the magnitude dealt with in the sectional organization of a fighting force, his mistakes will be fewer in number than those of the more haphazard methods now in vogue. That is enough to justify their use.

So much, for the present, about problems of selection. Even when you have selected material, however, there remains the question of how that material can best be trained. Here the psychologist comes in once more. There is now available a great amount of carefully-collected information of the course of normal learning of a large variety of human activities. Much of this has direct application to the training of the fighting man, and instructors would be all the better if they knew more about it. The questions raised at this point are so various and many of them are so specific that I can say little about them in a single lecture, and what I can say must for the most part be of a general nature.

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It is often assumed that, when a man is to be taught some kind of bodily or mental skill, all that is needed is that the task should first be demonstrated or described to him clearly and the rest comes by constant repetition. This, most emphatically, is a mistake. No skill of any kind is learned merely by routine. Repetition that is not backed by interest, an active urge of some kind to do the thing required, is utterly useless. A man may do a thing automatically, mechanically every day for a year, and be little or no better at the end than at the beginning. Apparently, it used to be popularly supposed that a good soldier is a man who simply does things and does not bother about reasons. This may be made into a great untruth. Of course, he does not constantly finger his own reasons, or those of his superior officer; but he is not so far removed from any ordinary human being that he can achieve any sort of efficiency without the provision of an adequate stimulus. What is an adequate stimulus must vary widely from individual to individual, but a good trainer will always make it his business to find out, and in so far as he does this he is a psychologist. With a few men, probably always a minority when the training is in fairly simple bodily activities, it is pride in the thing itself cleanly done. With more it is social, competition within the group or between groups, and this is a stimulus which the inevitable group organization of the fighting force makes it possible to use with great effect. With others, it may be, not direct social competition, but just the understanding of how what they are doing fits together with the part performances of others in a large combined plan of execution. Whatever it is, the trainer must know it and play upon it.

Another general point is often less considered than it ought to be. Just as there is no efficiency merely by repetition, so there is no real efficiency without confidence. Go back to the case of detecting the presence and position of aeroplanes or submarines by listening. Normally, we do much with our eyes, little with our ears. So when conditions force a man to rely upon his ears, he is apt to remain doubtful about the accuracy of his judgment. This doubt impairs his efficiency. How best to dispel a learner's lack of confidence is a psychological problem of some delicacy. Almost no general rules are possible. Often, however, a trainer may so arrange conditions that a task of the type required may be carried out with demonstrable ease and accuracy. The attitude of confidence thus set up may extend over to the precise activity which the teacher is trying to develop.

Even with first-rate learners and excellent conditions it must never be forgotten that the course of progress is rarely, if ever, uniform. Periods of improvement inevitably alternate with periods of stagnation or even of decline. This irregularity is often a source of unjustifiable annoyance. Its normality must be recognized.

More attention than usual ought to be given to the effects of

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distributed practice, particularly in the learning of routine operations. Very continuous practice is often definitely harmful. Distributed, or spaced, efforts generally have both better and speedier results.

Finally, it must be noted (1) that improvement may continue for very much longer periods than is commonly thought possible, and (2) that a bodily skill once learned may persist with extremely little practice for extraordinarily long times. A man's maximum efficiency, even in relatively simple routine operations, may perhaps not be reached for years, provided he can be kept fresh and keen; while once he is tolerably well-trained there is no need for constant, reiterated and boring practice. He will be more profitably treated if he is given plenty of time for recreation.

I have spent the greater part of my time in talking of the relatively concrete and unexciting questions of selection and training because they offer a field of immediate application to the organization of the fighting services. Conclusions within this field are well-established and definite. No doubt, the future will see great improvements of method and many new facts and principles will be discovered, but as far as they go, the main results are not now in the realm of dispute. These apart, however, there is almost unlimited scope for the application to a fighting force of more general, and perhaps less final, psychological observations. To some of these I will now turn.

A fighting force in the modern world is a large social group organized into a very considerable number of smaller groups, and its most important operations are group operations. Consequently, its main problems are those of the stimulation and control of social conduct. Obviously, an individual acting within a group and the same person outside a group are often remarkably different. The grouping itself introduces conditions which directly affect what he does. At the back of all social grouping there must be some active factor holding the group together, a tendency or a number of tendencies in the human mind or organism. In the case of the fighting group, this is the strong and almost universal tendency to vigorous and, if possible, pugnacious assertion. Lacking this, no decent fighting group can be developed, and if this fades away the fighting group becomes slack and inefficient. This pugnacious assertiveness is important not only in times of national crisis or of actual fighting, for directly or indirectly, it is this alone which can keep the group keen and alert during peaceful intervals. Hence, it has to be constantly stimulated and we must ask how, in the light of what we know about human nature, this can best be done. Obviously, the stress of civil competition, as the world is now organized, is, in a way, able to do this. The late War showed that great parts of the civilian population of most European countries have the pugnacious instinct very ready to leap into active expression. But this in itself is not enough, for war is now a combination of highly-skilled activities, and the pugnacious assertiveness that is at the base of the fighting group

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must be linked up with those very skills through which, when fighting comes, it has to be expressed.

The first essential, if this is to be done, is never to allow any unit, or sub-group, in the whole to get completely cut off and self-contained. The more isolated a group becomes, the more its bonds of organization slacken, and its keenness deteriorates. Social vitality demands that group shall be in touch with group, that the members of one group should be encouraged to know something of what the members of other related groups are doing and how they are doing it. This is, perhaps, the main psychological argument against a very highly centralized and unified command. There are some people who would like to see the great arms of a country's fighting services all controlled from a single source. Such a scheme I believe to be psychologically unsound. It might have certain initial and certain economic advantages, but in the long run it would be far more likely to devitalize the whole group. For again and again in social history, a group which has gained a position of supreme ascendancy and so has been able to ignore the criticism of other groups, has slowly but surely lost the driving force that once held it together.

Often it is possible to secure the contacts that are necessary in a professional sense. It is not easy to exaggerate the importance of having men and officers of one fighting unit attached temporarily to others, whether at home or abroad, whether in a native or in a foreign friendly service. Outside of these professional contacts a vast amount may be done by the organized group game. The latter method is already pretty fully exploited in this country. I have, in fact, met several people lately who think it is overdone. I cannot agree. The value of the hard group game, fought out at top speed, with all its pugnacity and assertiveness controlled and directed at every moment, is tremendous for the development of sound discipline and lasting morale.

Perhaps this final thing, the development of high morale, is the most difficult of all the general problems in the organization of a genuinely efficient fighting force. Much depends on the group leaders and upon their taking pains to understand the real basis of their power. But I have discussed this elsewhere, and I will close the lecture by considering briefly some other aspects of this problem.

Morale may be defined as a capacity to withstand persistent danger, difficulty, pain, distress and ill-success with enduring fortitude and good spirits ; and further to withstand great and unexpected success with a calm mind, glad, but not over-exalted by the tricks of fortune. Its basis seems to be a grim but optimistic courage. In the first place, what can be said about courage ? No man is born courageous, though probably many are born dare-devils. Dare-devilry goes blind, either naturally or wilfully, and fails to see danger. But courage goes open-eyed, and knows and faces the danger, controlling the natural impulses to escape. Hence, courage has always some-

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thing intellectual about it. It knows, and does not hesitate to study the objective facts of the situation. There is one characteristic about a fighting group which displays persistent steady morale in the face of continuous distress or continuous success that seems to me extraordinarily interesting. It is, I think, found without exception that every such group is capable of joking about the very situation that produces its distress or its exaltation without losing touch with the seriousness of that situation. All such joking about serious things turns upon a capacity to face the situation in an open-eyed manner, and neither to be swept by it into reckless action nor plunged by it into a mere welter of feelings. Broadly speaking, there are three classes of fighters. The first, faced by danger, are swept into immediate and unrestrained action. They may be recklessly brave, but they do not control their action by the immediate demands of the situation. Consequently they are apt to have little or no reserve, and to be overwhelmed by continued failure or continued success. The second are far more influenced by their own feelings than by the objective situation, so any depression or exaltation that may be set up causes them to lose sight of the real outside situation, and these again have little power to keep for long in touch with circumstances. The third are primarily interested in what is actually going on outside of them, and their own feelings about this, though they may be intense, take a secondary place. These are the people who can joke about a failure, or grouse about a success. It is this habit of mind which promotes high morale. Is it possible to train this habit of mind? I must leave that as a question, for there is no time to try to answer it. I will merely state that I am almost certain it is, and quite certain that if it is, its discovery must be a further instance of applied psychology.

One further practical point, and I have done. How may psychological knowledge be satisfactorily applied to the organization of an efficient fighting service? By the academic, laboratory psychologist? No. The problems involved are too technical on the fighting side, too special to be properly dealt with by anybody who does not meet them face to face all his life, who has not a first hand chance to know them inside out. Two things ought to be done. First, *every* Army, Navy, or Air Force officer ought to have a chance to know what a sane psychological point of view is. Many will not take the chance; a few will and it will do them a lot of good. This, it cannot be too strongly asserted, does not turn self-confidence into self-consciousness and produce a lot of odd and vacillating individuals who are for ever fingering their motives. If it does, it fails absolutely; but it never does, unless it has bad fighting material to work on from the beginning. Secondly, a few Service men who have a flair for this sort of thing, ought to have a chance of a thorough training in modern psychological method; not a book or lecture training merely, but what is far more important, a laboratory training. Then they

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can tackle the special and technical problems with a fair chance of finding valuable solutions.

Such more specialized training need not occupy a very long time. A man with aptitude and keenness who is efficiently directed can be set upon the way to work out his technical problems for himself within about twelve months. Obviously, a general introduction to the bearing of psychology upon Service problems should come near the beginning of a man's professional career, but the more detailed instruction in psychological methods has the best chance of achieving practical success if it comes a little later, when a man has already had some opportunity of learning for himself where the most pressing difficulties of organization and of Service training lie. The plan of offering to certain specially selected officers the chance of a training along the line of their particular interests and abilities, outside of regular Service courses, has already been followed in various directions and with admitted practical success. The time is ripe for widening that plan so as to include the possibility of specific training in psychology. Naturally, the plan would have to be applied judiciously and with caution, for it must be admitted that there is no subject that is a more happy hunting ground for the crank than psychology. But this danger could be very readily avoided. The best commanders at every age have been keenly alive to the need for considering the human side of the fighting forces whose activities they have controlled. With the gradual rise of the standard of education and technical skill of the men who make up these forces, the need for this type of consideration has become more and more pressing. I have attempted to indicate that modern psychology has already developed and organized a great amount of knowledge which can focus consideration of the human factors in fighting in a most practical manner. It has also built up methods by which such knowledge can be advanced most rapidly and accurately. For its bearing upon problems of the selection and training of recruits, the development of sound health of mind and body, and the foundations of social control, psychology may now fairly claim the serious consideration of all those who believe that the efficiency of our fighting services is a matter of the greatest importance in national organization.

Note.—It may be useful to add a brief list of publications in which some of the topics mentioned in this lecture are more fully discussed. If we take English publications only, the following will be found of interest :—

C. S. Myers : *Industrial Psychology in Great Britain.* London : Jonathan Cape, 1926, 7s. 6d. net.

C. S. Myers and other : *Industrial Psychology.* London : Home University Library, 1929, 2s. 6d. net.

E. Farmer and E. G. Chambers : *Psychological Factors involved in Proficiency and Accident Rate.* London : Industrial Fatigue Research Board Report No. 55.

T. H. Pear : *Skill in Work and Play.* London : Methuen and Co., 1924, 5s. net.

J. T. MacCurdy : *War Neuroses.* Cambridge University Press, 1918.

F. C. Bartlett : *Psychology and the Soldier.* Cambridge University Press, 1927, 7s. 6d. net.

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KEUAI RIVER BRIDGE.

By LIEUT. R. GARDINER, R.E.

THE following is a description of a job carried out during 1927–28, on the Central Indian Coalfields Railway construction:

General description.—The Keuai River in the Bijuri division of this construction is crossed by 6 spans of 60-ft. girders, on stone masonry piers. As originally constructed, there were pier abutments with the slopes of the approach banks stone pitched.

The river at the point of crossing has tended, for the last two years, to have its main stream on the west or right side, where the bank has been worn to a vertical cliff, some twenty to thirty feet high, whilst on the east side, a shelving bank of sand has been deposited with a gradual slope. On the west side, the rock is bare, whilst on the east side it is some twenty feet below the sand. The sketch gives a rough idea of a cross-section of the river bed along the centre line of the bridge. All the piers and both abutments had open foundations on the rock.

Monsoon, 1927.—In July, 1927, just previous to the monsoon, the bridge and approach banks had been completed except for the steel-work, which was still at the storeyard at Anuppur, 23 miles away.

Linking of the permanent way had reached mile 11, the Keuai being at mile 23, measured from Anuppur. There was a gap in the line of communication at mile 7, where the bridge across the Sone River was not complete. This prevented any heavy stores, such as girders and permanent way materials, being sent up the line. There were, however, sufficient permanent way stores already across the Sone to enable the linking to be continued to mile 21, and work was to continue throughout the rains. The Sone had been crossed by a diversion previous to the time in question (July), but this had been dismantled in the middle of June, in anticipation of the rains.

On the night of August 19th, after four days' nearly continual rain, there was an abnormally high flood in the Keuai River, and on the following morning it was found that, on the west side, the pitching and front slope of the bank had been washed away, and, on the east side, in addition to the pitching, 150 feet of the approach bank behind the abutment had disappeared.

Preliminary scheme.—Nothing could be done until the monsoon had ended and the river subsided, but a preliminary scheme was got out to build wing walls to the west abutment, and to add an additional span of 60 feet on the east side.

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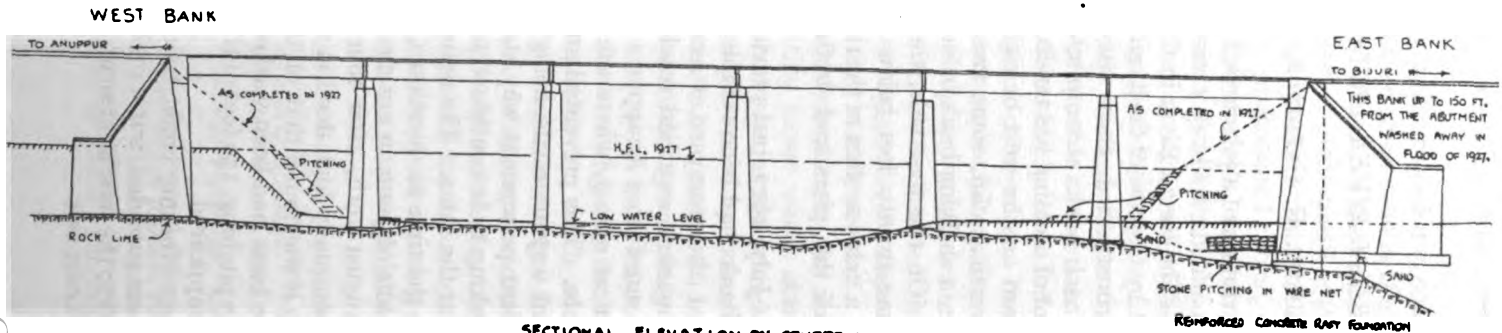
KEUAI BRIDGE, C.I.C.RY.

COMPOSITE SKETCH



SECTIONAL ELEVATION ON CENTRE LINE

DATUM 1600·0 FEET

ORIGINAL BED OF RIVER SHOWN THUS :- ~~~~~~~~~~~~

PORTIONS WASHED AWAY IN FLOOD OF 1927 :- ----------

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River diversions.—By the beginning of October, the linking had reached mile 21, and preparations were made to open the Sone diversion, round which the whole work of the division centred. This diversion was similar to the one made during the previous year, the waterway being of sleeper crib piers, with 75-lb. F.F. rail clusters. That at the Keuai was just under one mile long, and the waterway was spanned by a pair of 40-ft. girders. The gradient on the west bank was approximately 1 in 23 for a distance of 1,000 feet. A flatter grade was not possible, without making the diversion bank excessively high.

Further schemes.—Meanwhile, what to do with the Keuai Bridge was being further discussed. With the west abutment, the only and obvious plan was to add wing walls and so do away with the slope and pitching in front of the abutment. A point to notice here is that, although the bridge was of 6 spans, the effective waterway was only 4½ about, the remaining 1½ being blocked by the slopes in front of the abutments which had originally extended to the foot of the first pier on each side. With the addition of wing walls, however, the full 6 spans were open to the river. It was thought that this may have had quite a lot to do with the damage done in August, in that the water may have been banked up on the upstream side of the bridge, topped the pitching and worked a way behind the abutment.

The time factor.—In deciding what course to take, time was an important factor. It was intended to open the first section of the line, as far as Bijuri at mile 30, before the rains of 1928, the first date given being the 1st May. The first suggestion, as already mentioned, was to turn the east abutment into a pier by adding masonry cut-waters and building a new abutment with wing walls, thus adding another span. The necessary girders for this were at Anuppur.

Drawings were got out and excavations started in November for this new abutment and the additions to the old one. In the first week of January, however, after having got down to about three feet above water level, it was discovered that in order to reach rock at the site of the new abutment, there was still 18 ft. to be excavated. Under the circumstances, this was an impossible task, and all idea of adding another span had to be abandoned. The only thing left was to add wing walls to the east abutment, similar to those already in progress on the west side, and the excavation of the foundations was started immediately. The intention was to found the walls on the rock, but it soon became apparent that even this would take too long, as it was found that the rock shelved both north and south of the abutment, and at the end of the proposed wings was 13 ft. below water level. The difficulty was that this 13 feet consisted of nothing but sand, and in order to reach this depth, the sides of the excavation would require continual shoring and a coffer dam of some sort.

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Final scheme.—Foundations.—The sketch shows what was finally decided upon, namely, to give up attempting to reach rock and to found the wing walls on the sand, using a strongly reinforced concrete raft, on which to build the masonry superstructure. This concrete raft ran continuously behind the abutment, and the masonry was built right up against the abutment, but not bonded to it in any way, thus leaving the walls free to settle if they want to.*

The reinforcement took the form of 75-lb. F.F. rails, laid with their lowest portion 6 in. above the bottom of the concrete, and at 4-foot intervals. The concrete was of 1 : 3 : 6 proportion, using cement, and 3 ft. 4 in. thick. In order to ensure having the full 6 in. of concrete below the rails, approximately 8 in. of concrete in empty cement bags was first laid and the top surface got as level as possible. This also prevented any chance of the concrete being weakened by coming into contact, when laid, with the wet sand.

Superstructure.—Once the concrete was complete, the masonry work was straightforward, and only a question of hustling the contractor. The stone came from a quarry on the west bank and was brought to the site by a Décauville tramway, the distance to the east abutment being just half a mile. In order to speed up the progress, courses of concrete were used with a masonry skin, each pair of these mixed courses having a complete masonry course between.

In spite of all efforts the date of opening had to be postponed from the 23rd May until June 16th. The west wings were completed, except for the coping, on May 15th and the east wings on May 29th.

Earthwork.—Behind the east abutment there were approximately 7 lakhs (700,000) cu. ft. of earthwork to be done, and the contractor responsible kept pace with the masonry. The height of the bank was 50 ft. and, therefore, considerable settlement was to be expected, particularly as we should be opening the line only a few days after the completion of the work, and also as the rains would commence very shortly afterwards. In order to counteract this and to obtain as much sinkage as possible previous to opening, each day's work by the contractor was well watered.

Owing to the urgency of the job, a 10-ft. bank with as steep a slope as possible was first put across the gap, and then the permanent way linked on to the bridge. Low-sided wagons were then filled with earth which was unloaded on this narrow bank.

In order to further counteract sinkage on the approaches, the top 18 in. of the banks were made with stone soling, of about 9 in. in size, this being hand-packed as close as possible for a distance of 50 feet from the abutments. This gave a good bottom for the ballast, and also spread the pressure from the traffic over the whole width of the bank.

* The north wing wall sank approximately half an inch shortly after the earth behind had been filled and after the first shower of rain.

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KEUAI RIVER BRIDGE.

The 40 ft. span in the Keuai diversion being launched.

The 40 ft. span in position.

The reinforcing rails in position and further concreting in progress.

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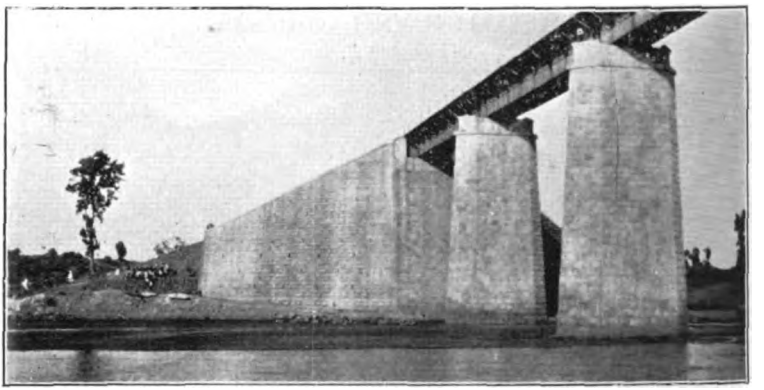
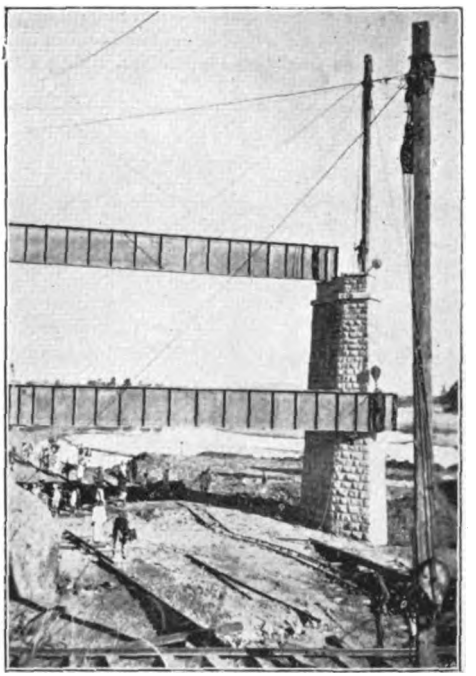
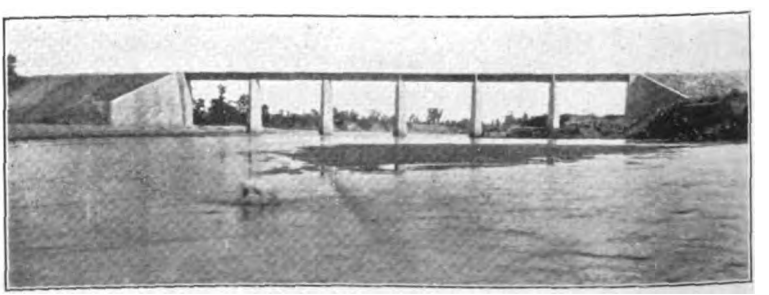


The completed East side wing walls.



The erection of a 60 ft. girder.



The Bridge as completed, 1928.

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It should be noted that the wing walls were designed to be entirely self-supporting structures, and did not rely on any support from the abutments. A batter of 1 in 8 was allowed on the front faces.

Protection of foundations.—The wings on the east side were, as has been explained, founded simply and solely on sand, and some steps were necessary to make sure that this sand could not be removed by scour at some later date.

The following suggestions were put forward and the last one finally adopted.

(*i*) To put in timber sheet piling all along the front face of the concrete raft foundation reaching to rock. The tops of this sheet piling to be tied back into the masonry, so that if the sand in front should scour away, the pressure of the sand behind would not push the piling forward.

(*ii*) To lay a thin concrete (reinforced) apron on the sand all along the front of, and extending to about 50 ft. from, the face of the wing walls. This apron to be carried well upstream and downstream of the bridge.

The idea was that, should scour occur, it would do so first at the edge of the apron, which was to be 40 or 50 feet in front of the abutment and wing walls. The apron would then gradually sink on its outer edge, until it finally reached the rock. Thus scour would then automatically cease. This and the third scheme were both helped by the fact that there was a ridge of rock running at right angles to the centre line, 30 feet in front of the abutment, and the top of which was about level with the bottom of the wing wall foundations. Thus the outer edge of the apron would only have had about 4 feet to sink.

(*iii*) In place of the concrete apron, one of stone pitching or boulders laid in wire netting—but otherwise performing the same functions as the concrete apron. In this case, wire netting of 1-foot mesh made on the site was first laid on the sand, and then stone pitching of as large a size as possible laid on top. At the forward edge it was 4 feet thick, and at the back, against the wing walls, 10 feet. Here again, in the event of scour, the front edge would drop first, and on reaching the ridge of rock, would prevent any further scour taking place. The wire netting was turned back over the top and tied back under the top layer of pitching.

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ECONOMIC READINESS FOR WAR.

A Lecture delivered at the S.M.E., Chatham, on 21st February, 1929, *by* L. C. ROBBINS, Esq.

I.

IN my remarks this evening I want to do two things. I want, firstly, to discuss the general problem of economic readiness for war as it may present itself at any time to any nation. Then, secondly, I want to discuss the special nature of this problem as it presents itself to us, citizens of this small island, in the year of grace 1929. Needless to add, what I have to say on both parts of my subject will be very crude and lacking in precision. It is not possible in a single hour to do justice to what, after all, is one of the great problems of modern civilization, but it seemed better to attempt to provide a general view of the subject as a whole than to spend the time in mapping out in greater detail only a part of it.

II.

I turn first then to the general problem. How best can a nation make provision for the contingency of war? How can it secure a continuous supply of the things that are essential to a satisfactory issue of any probable conflict? How can it secure enough guns, enough ships, enough food for the maintenance of its civil and military population?

Now it is important, I think, that we should realize that this problem is not always present. The possibility of a real shortage of war material and foodstuffs may not always have to enter into the considerations of statesmen. There may be still a problem of how best to transform existing resources, of how, given a sufficiency of ploughshares, they may most rapidly be beaten into swords. That, of course, is a problem which must always be present when the needs of war are greater than the provision which is made in time of peace. But if a nation produces—or can produce at short notice—all those materials which it is likely to need in war time, then no problem of the kind I have to discuss to-day need enter into its calculations. It runs no danger of the cutting off of supplies from potentially hostile countries, or of the cutting off of supplies from friendly countries or colonies by hostile blockade or siege. Its problems, such as they are,

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are all problems of organization, and difficult as these may be, they are still of the second order beside the problems I wish to examine.

Now there can be no doubt that for very long periods of history many nations were to all intents and purposes in the position I have just mentioned. Save in the case of very small city states—whose condition, curiously enough, was more closely akin to what ours is nowadays—the problem of how to secure essential supplies of food and war material was not one which greatly troubled our ancestors. The outbreak of a war might produce grave disturbances in the luxury trades—it was with the exchange of luxuries that trade between nations in those days was very largely concerned—but these, after all, were not essential to the business. Bare subsistence for the population, sufficient armour and the rest for the military forces—these were not likely to be absent.

In modern times, however, the number of States which in this respect can be regarded as self-sufficient has greatly diminished. In the absence of special provision for the purpose, there are now few important States which would not suffer some direct inconvenience, of the sort I am discussing, in the event of the outbreak of war on a large scale. The United States is perhaps an exception, though I fancy that the problem of rubber supply may from time to time cause her experts some misgiving. But leaving the new world on one side, there is no European nation which can regard its position in this respect as being in all respects satisfactory. It may be well supplied as regards food—as, for instance, pre-war Russia—yet be lacking in guns and munitions. Or it may be well provided with the means of producing ammunitions—as, taking a broad view of the matter, we ourselves can be said to be—yet be utterly lacking in an adequate supply of foodstuffs. I have chosen glaring examples, but in lesser degree everywhere there are parallel disabilities.

How is it that this change has come about? It will elucidate the main problem, I think, if we go into the matter a little further.

(1) Partly, I think, it is due to what, as an economist, I classify as changes on the demand side. The technical changes in the art and the scale of war make the procuring of the necessary materials a matter of much greater difficulty than it was at earlier periods. In early times, when the various weapons employed were so undifferentiated and simple that a representative collection can be kept in a single glass case in a local museum, there can never have been much difficulty in procuring a sufficiency of materials, even if the iron ore necessary were not produced within the borders of the nation. It cannot have been difficult to procure a sufficient supply in peace time to furnish all the weapons necessary for the longest conflict. In those times, I am told, a good knight used a Toledo blade. I have never heard that an insufficiency of Toledo blades prevented good knights fighting with one another.

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But if you turn to modern times, what a difference you find. Instead of a few steel instruments you have a variety of complicated appliances, for the manufacture and service of which the resources of whole continents may be insufficient. These are matters on which it is not necessary for me to dwell in addressing an expert audience. It is clear that to satisfy a demand of this *qualitative* complexity the small resources of single nations must often prove insufficient.

Moreover, and this is a point which is not so frequently realized, the mere *quantitative* demands of modern war are so great that even if, in the absence of special provision, *some* products of the kind desired are produced within the national boundary, yet it is not improbable that, in a major war, the total national production may prove insufficient and have to be supplemented by similar products from abroad.

(2) All this has been brought about by changes in the technique of war, changes acting, as I have put it, on the demand side of the problem. But beyond this there has been a series of changes on the supply side, changes unconnected with the technique of war, but vitally bound up with the development of economic organization in general, which still further complicate the position. I refer, of course, to increasing specialization of national production. If nations produced within their own borders all that it was *possible* for them to produce, the requirements of modern war are such that it is probable that there would yet remain many important raw materials for the supply of which they would have to depend on other parts. There would still be a problem of ensuring a proper supply of these materials during time of war. But, in the actual world we live in, the situation is still further complicated by the fact that we do not produce many things that we could—or if we do produce them we do not produce them in such quantities as we might—preferring to procure our requirements in these respects by exchange with other peoples. In such circumstances, the dislocation which may be caused by cessation of trade either by way of war or blockade becomes much more serious.

It is not difficult to see why it is that specialization of this sort has come about. After all, territorial specialization—division of labour between the inhabitants of different parts of the earth's surface—is almost as obviously convenient as personal specialization—division of labour between individuals. It is obviously convenient, from the point of view of production, that different people should do the different jobs for which they are best fitted, and it is scarcely less obviously convenient that different groups of people, inhabiting different parts of the earth's surface, should put their resources to the uses for which they are best suited. This is true even when the efficiency of different men or different lands for all kinds of jobs are on different levels. An officer may be better than a private, both as officer and private, yet it is better that he should stick to the function

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he can do best, and the private to his. A piece of land in the city may be superior to a piece of land in the country, both as a site for offices and as a cornfield, yet it is obviously better that it should be reserved for offices and the other kept for corn growing. If there were no danger of war, there can be little doubt that the widest possible division of labour between nations would be regarded as desirable, and there can be little doubt that it is its obvious commercial advantages which, the danger of war notwithstanding, have led to the very high degree of territorial specialization which is characteristic of the world as we know it.

Moreover, it must not be thought that, from the point of view of national power, wide ramifications of international trade are altogether without their advantages. During the recent war it is clear that our own dependence on foreign supplies was a source of many dangers. On the other hand, when we reflect how much of national wealth has resulted from our trade relations and when we reflect what a tower of strength this national wealth was for us and all our allies, it is hard to believe that even from this point of view our position as a trading nation was altogether a disadvantage.

Nevertheless, in a world in which it is impossible both to have your cake and eat it, it is clear that developments of this sort must be a source of anxiety so long as the danger of war persists. For, quite clearly, specialization of the sort I am discussing is not always a process which is reversible. If it were merely a question of putting given resources to certain uses during time of peace and putting them to different uses during time of war, all might be well. The problem would be merely one of rapid adaptation. But, of course, it is not so. For one thing, capital and labour which have been specialized to do one thing, cannot always be rapidly re-adapted to do others. For another, the very process of specialization may make possible a concentration of population which could not otherwise be supported. For example—to anticipate a little—there can be no doubt that our own high degree of industrialization has made possible a density of population of a degree which could not easily be supported by a less highly specialized organization of industry. It should be clear then that these changes on the supply side, that I have been discussing, introduce complications of no inconsiderable magnitude.

It follows, I think, from all that I have been saying, that the problem of economic readiness for war is essentially relative. It assumes different forms for different nations at the same time, and for the same nation at different times. You cannot say that it is a question of supplying so much of commodity A, so much of commodity B, over and above the normal production of these commodities. Everything depends (*a*) upon the geographical circumstances of the nation you are considering and its trade relationships with the rest of the world, and (*b*) upon the demands which the type of

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war you are likely to wage is going to make upon its resources. One nation may find its chief difficulty to consist in the supply of foodstuffs, another in the supply of shipping, a third may chiefly need coal—and so on.

None the less, if we approach the problem with a view to the discovery of practical solutions, we can make a certain formal division which I think is "useful."

(1) In the first place comes the problem of securing a supply of commodities which cannot in any circumstances be produced in sufficient quantities within the national area. Minerals of various sorts will be the most numerous members of this class in most cases, but, in some circumstances, vegetable and even animal products may be included. For all practical purposes, for instance, it would be impossible to produce all the rubber needed in a great war within the glass-houses of these islands.

(2) In the second place comes the problem of securing a supply of commodities which could be produced in sufficient quantities within the national area, but which, for the reasons of economic convenience I have explained, are not so produced in the normal process of trade. Illustrations of the sort of thing I have in mind will readily suggest themselves to the members of this audience.

So far as the first of these problems is concerned, the possible solutions are severely limited. The possession of adequate supplies of some commodity falling under this head may be a matter of life and death to a nation, but short of the forcible acquisition of the sources of supply—a solution which, I hope, at this stage in world history would be unacceptable to any of us—there are only two ways of securing them. Either you can accumulate a sufficiency during time of peace, or you must see to it that your communications with the sources of supply are adequately safeguarded in time of war. There is no third alternative open.

But so far as the second problem is concerned—the problem of securing a supply of things which could be produced at home but are not—a wider range of action is possible. If a thing can be produced at home, then, if the State decides that it is desirable that it should be so produced, it is possible to take steps to carry out this policy. It does not follow that the State will make this decision: it may decide that such a policy would be too costly. It may prefer, as in the case of the other class of commodities, either to accumulate during time of peace, or to pay attention to the safeguarding of communications. Clearly this is a matter of balancing costs and results. If the extra cost of domestic production is small, as in the case of the so-called key industries, the probability is that domestic production will be encouraged. If it is great, then it may be decided that, on balance, it is better to trust to the Navy—or those forces which are charged with the maintenance of communications.

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Once it has been decided to produce at home, there are various ways in which this policy may be carried out.

(1) The State may go into business itself, erecting the necessary plant and carrying out the process of manufacture. This is most likely to happen where the commodity whose production it is desired to foster is one which is chiefly needed by the State itself in the direct performance of its functions. Armament manufacture is, of course, a case in point. Few nations of any importance are likely to be content to procure all their armaments from abroad. Most have, at some time or another, done some of the production for themselves.

How efficient such an arrangement is likely to be is, of course, a question which it is difficult to answer in advance. Those who regard State enterprise as uniformly desirable will predict great efficiency. Those who think that State enterprise is the work of the devil will be of the contrary opinion. Most of us, I imagine, will be content to judge particular cases in the light of particular circumstances. It is worth noting that sometimes, from the point of view of secrecy, this plan is superior to other arrangements.

(2) Secondly, it may subsidize the form of production it is desired to encourage. Such subsidies may be either open or concealed. An open subsidy is a simple matter. A certain sum per unit of output is paid to the producers in question. Concealed subsidies, as their name implies, may be much more complicated. The most obvious are grants of special transport facilities. If the producers of certain kinds of goods receive especially low rates for transport on State railways or canals, they are receiving a subsidy just as much as if it were paid them directly. Similarly, if the government always places orders with home producers at prices higher than it would have to pay abroad, it is paying a subsidy to these producers just as much as if it handed over a sufficient sum of money to enable them to under-bid the foreigner in the first place.

(3) Finally, it may impose such a duty on foreign imports as to make the price prevailing profitable to domestic producers. This is a familiar device and needs no special description.

Of these two methods, subsidies and tariffs, it is difficult to say which is the better instrument. A tariff has often the recommendation of administrative convenience. But against this it can be urged that it tends to throw the cost on the shoulders of people not always the best fitted to bear it. This would certainly be the case with a bread tariff. A subsidy on the other hand, being, in the first instance, paid out of the national exchequer, rather than the pockets of the consumer, can be raised by graduated taxation, and is therefore immune from this objection. Moreover, from the point of view of the citizen, anxious to live as cheaply as he can, there is always this in

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favour of a subsidy: it tends to come off; a tariff, on the other hand, tends to stick. On the whole, people are more alive to what they lose as taxpayers than to what they lose as consumers.

III.

That is all I wish to say about the general problem. I now turn to the consideration of the special problem with which we in this country are confronted. How ready are we for war, from the point of view we are adopting?

Now, speaking very broadly, I do not think that, as regards the supply of the direct instruments of war, our position is at all disturbing. No doubt there are raw materials essential to the conduct of modern warfare which are not to be found within these islands. The problem of providing a sufficient store of these does not seem to me very difficult. And so far as the manufacture of war material is concerned, our position is surely very favourable. The experience of the last war has shown that there are hundreds of factories which, at very short notice, could be transformed for the manufacture of munitions. The problem here is simply a problem of preparing suitable plans, and being willing to act on them without hesitation.

As regards our food supplies, however, it is not possible to be so complacent. Indeed, I do not think it is any exaggeration to say that our position is one of almost unique disadvantage. I must ask your patience a little further while I enlarge on this matter.

The change in the position of this country as regards food supply is, I suppose, a classic example of the way in which the process of territorial specialization which I was describing earlier in my lecture, although enormously advantageous from the point of view of productive efficiency, may lead to a quite peculiar position of danger from the point of view of military security. Two hundred years ago, in normal years, this country was self-supporting as regards foodstuffs. In normal times, indeed, we produced a slight surplus for export. In spite of the growth of population, that position remained roughly unchanged until the beginning of the nineteenth century. But from that time onward there came a change. With the development of world transport, it became cheaper for us to obtain a larger and larger proportion of our food from abroad. Rather than cultivate poorer lands or expend our capital and labour cultivating lands already in cultivation more intensively, it paid us to use our resources in manufacturing industry, obtaining our food supplies by way of exchange for our industrial products. That change in the character of our national production has persisted right down to the present day, with the result that we are now dependent on sources overseas—sources from which we might at any time be cut off by blockade or naval defeat—for at least 60 per cent. of our total food supplies. Speaking very roughly

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indeed, 80 per cent. of our wheat and 40 per cent. of our meat, comes from abroad. Our dependence on foreign or colonial sources for eggs, sugar, fruit and other minor items of the national diet is also very considerable. That is a position, I suggest, which, if war is to be regarded as a permanent fact, can be regarded by no one with equanimity.

But the way out is not apparent. It is not possible simply to reverse the policy of a century. If the population of to-day was the population of a hundred years ago, all would be quite simple. We might prefer to get our food abroad in time of peace, but in war time we could plough up our meadows. That solution to-day is not open to us: the population is too numerous. It is almost as though you were to hope to support the inhabitants of the City on the produce of London Squares. No doubt it is possible to extend the area of cultivated land in this country—on that I shall be saying something further in a moment. But I think you may take it as an axiom of policy that it would be quite out of the question to produce at home all the food needed for our present population, save at the cost of wiping out the material gains of a century. These are strong terms, but I am not alone in this opinion. Let me read you the opinion of the late Deputy Director General of Food Production.*

"It has been asked," says Sir Thomas Middleton, "is it not possible for the United Kingdom to feed its entire population, or at least to supply all necessary foods, except the small percentage that could only be grown in tropical or semi-tropical climates? From the purely agricultural point of view it may be answered that there would be no special difficulty, if the people of this country were content to place themselves under the direction of some all-powerful food controller, who would feed them with what was necessary, as a farmer feeds his cattle. If they would be satisfied with the rations of protein, fat, and carbohydrate which their bodies must have, and if they would be prepared to pay for their food on a calorie basis, the farmer could, no doubt, supply the necessary protein and energy. But the public would not be content with rations of protein, fat, and carbohydrate, and would not pay on a calorie basis. They must have bread, meat and many other things in certain customary quantities: and thus, under present circumstances, or under any circumstances that can be foreseen, there is no possibility of providing the foods they demand from the soils of the United Kingdom. It would require more than twenty million acres of land to supply the grain alone that is consumed in this country, and to secure this quantity of grain it would be necessary to plough every acre of land not subject to flooding and not too far above sea level to prevent corn from ripening. The cost would be prohibitive, and the suggestion that we might furnish our people with their normal food supply may be dismissed as absurd."

It is clear, therefore, that to some extent food falls into the

* *Food Production in War*, p. 323.

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first of our two great classes of commodities—commodities which cannot be produced in sufficient quantities within the home area—and as we saw, the only way of ensuring a continuous supply of such commodities during war was by the safeguarding of communications or by storage during peace time. In the case we are discussing the latter policy can, I think, be dismissed as impracticable. Before the war, the possibility of building great granaries for storing corn against the contingency of war was sometimes discussed, but it is not heard of now, and I should suppose—I speak subject to correction—that recent developments in the art of aerial warfare rule it out of court completely. If there is to be war, the main source of security is and must be the safeguarding of communications.

Of course, within limits, the supply of food is capable of variation. A policy of subsidies or tariffs would produce some extension of arable farming. At the height of our effort during the War we succeeded in raising supplies for 155 days out of 365 instead of 125. We could also in course of time reduce the pressure by redistributing our population through the Empire. It is conceivable that in the course of the next century the continued fall in the birth rate may bring about a similar relief.

But when all is said and done, it cannot be pretended that the position is anything but profoundly disquieting. There was a period during the War when we were but three weeks off starvation. If a new war were to break out next year against a naval power, I see no reason to suppose that the danger would be greatly diminished. The very forces which have brought us so high in the industrial world have placed us in a position of economic insecurity in time of war, from which, so far as I can see, there is no way of escape. One error of judgment on the part of the commander of the Grand Fleet, and the fate which was Germany's and Austria's, might be ours also. A terrible responsibility rests upon the shoulders of those who are responsible for the conduct of our foreign relations.

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INSPECTION OF BUILDING WORKS.

By CAPT. A. MINNIS, R.E.

THIS article is primarily intended for the guidance of the young officer on first appointment to D.O. work, and for field company officers, whose tradesmen may be employed during the winter training season on buildings.

Even the most self-confident of us must find it difficult to appear authoritative when criticizing work under the sardonic eye of a foreman old enough to have built the house we were born in, and in such a situation ignorance is the father of embarrassment.

All the matter which follows is (or should be) common knowledge; but the reminders here given may focus such knowledge and give the young officer inspecting his first job something definite to look for.

Only the most common mistakes and malpractices are mentioned; the finer points of building inspection will be learnt by experience.

A word of warning may not be out of place; be careful what work you condemn, and when. It often happens that a job is so far advanced when a defect in earlier work is noticed, that it cannot be remedied without great expense. If such a thing should happen, you are practically bound to let it go, partly because, by not seeing the fault at the time, you have tacitly passed it, and partly because work dismantled and rebuilt can seldom be made really sound.

Therefore, inspect work thoroughly and often.

It should be borne in mind that this article is necessarily written with the idea of pointing out faults and frauds—one does not inspect building work in order to admire it, but to see that it does not fall below specification.

For this reason, the general impression may be given that contractors are all cheating sharps, and workmen all lazy scamps.

That attitude of mind must be avoided; as a rule, contractors are honourable and workmen conscientious; a moment's thought will show that their own interests are best served by giving value for money. At the same time, there are others.

It is better to trust contractors or workmen until you have reason for distrust, than to consider them rogues until they prove otherwise. If you go about with the obvious intention of finding fault with all you can, the contractor will retaliate by giving you the minimum standard of quality in everything, counting a point in the game to himself for every time he succeeds in getting the better of you.

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The attitude calculated to get the best service from everyone concerned with the carrying out of building works is extremely well shown in the article by Capt. Tosh in the March issue of the *R.E. Journal.*

DRAWINGS.

Make sure that the building as designed will fit the site. W.D. designs usually assume a level site and sound foundation soil at a moderate depth. Your site may necessitate modifications, especially in the matters of floor levels and drainage.

Trial pits should be put down in case of doubt as to the quality of the foundation bed.

SETTING OUT.

The contractor will usually do the setting out, but you must make a check before excavation is commenced.

WORKMEN'S CONVENIENCES.

Before any work is commenced, latrines for the workmen, and a shelter in which they can have their meals (where no such place is already handy), must be provided. Unless these provisions are made, the building itself will become both.

EXCAVATION.

Foundation trenches become puddled at the bottom, due to workmen walking about in them, and it is difficult to judge them by the appearance of the bottom, except in the early morning after the mud has had a chance to settle, when running water from small springs can be detected. Generally speaking, it is better to judge trenches by the condition of their sides. Widths and levels should be checked by measurement.

When the bottom is stepped in sloping ground, see that the terraces are level, and the steps a multiple of the height of a brick course in depth. Concrete to these terraces should overlap at the steps (*i.e.*, each step must have a concrete "riser" as thick as the concrete foundation itself).

Pegs are usually driven to show the actual depth of concrete by indicating the level of the surface. See that concrete is actually placed at several places to these peg levels before you leave the job.

Contractors have been known to drive all the pegs down a few inches when this precaution has been neglected.

DRAIN LAYING.

Pipes.—Good pipes ring like sound crockery, are straight, and show no pimples or abrasions in the glazing.

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Joints.—Joints are most likely to be scamped underneath. When bricks are used to pack up pipes to make the underside of the joints accessible, care must be taken (unless the pipes are bedded in concrete), to remove them as soon as sufficient earth has been filled under the pipes to hold them up. If these bricks are left in they form rigid supports, and the pipes may break when the earth above them settles down.

Sight test.—Straight lengths of drain should be inspected by using a mirror at one end to reflect the light of a candle placed at the other, when any fixed obstructions (such as cement mortar), likely to hold up paper, etc., will show themselves. If they cannot be removed by pulling through a wad of rags, you will have to decide whether to have the drain relaid or not. Obviously, such an obstruction is more serious in a flat drain than in a sharply-graded one, and on the bottom of the pipe than on the sides or top.

Water test.—The water test should be applied before and after the trenches are filled in, the first time so that defects may be easily remedied, and the second to ensure that damage has not been done during filling.

This test is automatically applied if a stoppage occurs, so that any objections the contractor may raise on the grounds of its severity should be overruled. Make sure that no taps draining into the system are left dripping to replace water leaking away during the test.

CONCRETE.

It is not proposed to go into the subject of cement quality here; any book on materials contains details of many tests, field and laboratory, which may be carried out if doubt is felt as to the quality of cement.

Nowadays, cement from a reputable source may be relied upon to pass the British Standard Tests, so long as it is fresh and has been stored in a dry place. If cement is more than six months old, or has been kept in a draughty or leaky shed, it should be tested by one or other of the approved methods before it is passed for use.

Concrete mixing should be supervised as carefully as possible, to see that the specified proportions are adhered to.

Do not be fussy about the wetness or dryness of the mix. In text-books, a great deal of stress is laid upon the necessity for using the smallest possible allowance of water. It is true that a "dry" mix gives the best laboratory results; it is equally true that workmen cannot be made to use it. Even for mass work it is hard to "work"; it sticks to the shovel and requires a great deal more ramming to consolidate it than it will ever get. It would, therefore, be liable to be honeycombed with holes, were it not for the bucketful of water which the labourer keeps at hand "for washing his shovel." As you will certainly get wet concrete when your back is turned, you may as

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well have it all the time, knowingly, instead of pretending that it is "dry." Uniformity in quality is the first essential.

For reinforced work, the concrete must be sufficiently soft to flow slowly, otherwise it will not get into proper contact with the steel; and the more complicated the reinforcement, the less the chance of proper tamping being done and the more fluid must the concrete be.

If the work is sufficiently important to warrant it, the weakening effect of using a wet mix should be compensated for by increasing the allowance of cement, otherwise your only worries should be to see that your concrete is not really sloppy, and that all batches are of the same consistency.

Do not allow "killed" cement to be used; that is, a mix more than two hours old. Workmen like it because it "works like butter" if it is turned over with a little more water.

Ensure that concrete is mixed on a "banker." To utilize a hard road or paving is common with contractors, consequently dirt from road or paving gets mixed with the concrete.

Salt water does not affect the ultimate strength of concrete, but it retards the setting. It should never be allowed for buildings, because the concrete will always be slightly hygroscopic.

Concrete floors.—The only satisfactory proof that concrete floors have been laid to an even fall is to swill them with water and note whether any pools remain.

REINFORCED CONCRETE.

This article can cover only a few of the more elementary points to be noticed in R.C. work.

Lintels.—Unless a lintel has a distinctive outward appearance, which will show definitely its right way up, there is a danger of it being placed with the steel on top, where it is useless. The only safe way of avoiding this is to put in steel at both top and bottom. Where lintels run continuously over one or more intermediate supports, double reinforcement is more practical and fool-proof than the most careful bending of bars to take up stress variations.

Beams.—Fill in concrete from one end, working straight through to the other. To keep the steel at its proper distance from the bottom of the form, a piece of piping should be placed about two feet from the end of the beam, underneath the bars, and pulled forward as the concrete is filled up to it. Wherever possible, beams should be filled in one operation, but if work planes are unavoidable, keep them at places between the points where bending and sheer stresses are at maximum, usually at about quarter-span.

Columns.—Columns over 8 or 10 feet high cannot be filled in one operation with certainty of solid filling. The bases and caps, especially the latter, will usually be subject to stresses due to beam

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connections, and must be completed along with the ends of such beams, in one operation. No interruption of filling must be allowed at mid-height of the column ; so that work planes must be at about quarter and three-quarter heights.

Steel.—Reject all bars which are not perfectly straight between intentional bends. See that steel is brushed before use and is free from grease or oil.

Concrete.—This has already been referred to. Remember that the wetter the concrete, the less the punning required or desired. Punning concrete always tends to separate the water and cement from the aggregate, and this is especially so in the case of wet concrete.

Forms.—Forms should be watertight, smooth where the work is required to show a finished surface, and covered with oil, or an emulsion of oil and water, to prevent adhesion of the concrete to the timber. When the work is set, strike forms gradually, taking down the sides of beam-forms first.

Mortar.

The sand used for lime or cement mortar must be clean. Contractors like dirty sand, because the more loam or clay there is in it, the less lime or cement it requires to make it work fat.

Pick up a handful of the sand and work it about with your fingers ; if it soils your hand, it should be rejected until washed. Crushed bricks make a good " sand," but old lime mortar should not be allowed to be ground up for re-use.

For lime mortar the sand should be sharp. You can test this by rubbing a pinch of it between fingers and thumb, when it should feel harsh to the skin. For cement mortar, sharpness does not matter ; some authorities go so far as to say that round grains are better. Lime used for mortar must be specified to be measured before slaking. This is the usual assumption, but contractors have been known to pretend, when nothing was written in the specification about this, that they thought otherwise ; and as most building limes nearly double in bulk after slaking, such a misunderstanding may mean a 1 : 4 mix instead of 1 : 2.

Bricks.

Good bricks are even in colour (unless specially made for a special colour effect), burnt through, have straight sharp edges, and are truly rectangular on all faces. Any bricks containing stones, or showing lumps or marked faces, should be rejected. A good brick rings like a good coin when struck with a trowel. Clamp-burnt bricks usually have a marked face and should not be rejected on this account, unless, of course, facing bricks are wanted.

Note the number of broken bricks when a load is delivered. There

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will always be some, and such are necessary for bats and closers; but suspect the brickwork when there are too many. A contractor will not go to the expense of carting them away; they will be built into walls as snap-headers and hearting when your back is turned.

BRICKLAYER.

Finished brickwork can only be judged by its appearance. See that perpends. are true, the bed joints horizontal and straight, the quoins plumb and the face without any trace of bulges. Bonding will rarely be defective *on the face;* never if the perpends. have been "kept."

It is whilst brickwork is being laid that faults can be seen—finished work shows nothing of the crimes committed behind the face. For this reason, brickwork is probably the most exacting part of building work to supervise; to be quite sure that work is well done, it must be watched continuously. As this is usually out of the question, it is safe to say that a large proportion of brickwork is not up to specification.

So long as supervision is maintained, headers are headers, joints are flushed with mortar, and the hearting of a thick wall is built of whole bricks.

When you are not on the job, a bat becomes a header, bricks are laid on a fid of mortar at the back and front, with nothing under their beds, and the hearting of thick walls is made up of spalls and rubbish.

The flushing of mortar joints is extremely important if a wall is to be really weatherproof; but it is expensive in material and labour. Even if the contractor is scrupulously honest, the bricklayer may not be; it is easier for him to lay bricks without flush bedding; also he considers his beast, the hodman, who has to carry mortar up to him.

It is easier to press down a brick to its level when the joint is not flushed, or when the brick is laid with the frog downwards, but in neither case will the wall be solid.

Bricks must be wetted to avoid soaking up moisture from the mortar.

Damp courses must be set above ground level *all round the building*, and try to allow for probable banking up of flower-beds by the occupant.

You cannot legislate for the individual who builds rock gardens against the wall of his house, but you can usually foresee flower beds.

Slate damp-proof courses are often scamped. See that each slate is well bedded in cement mortar, and that the courses of slates break joint.

A common error in building hollow walls is to lay the D.P.C. on

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the top of the solid wall and commence hollow construction from that level. This does not allow for the drain, provided for condensation and other water, to lead water away below the D.P.C., and it will soak up the wall. Therefore, put in your D.P.C. a course above the bottom of the cavity so that water in the bottom will not wet the brickwork above.

Bonding faults, which are rare, will not occur on the face of a wall, but may usually be detected by pushing a length of hoop iron vertically down a joint near to a jamb or a return. "Awkward" bonding is usually the fault of the architect, who has not taken care to plan his piers and openings to multiples of a half-brick in width. It will usually be possible to make the slight alterations needed, (which can never be more than 2½ in.) to correct this; but you must do it before the woodwork for doors and windows is put in hand.

In setting out brickwork, see that reveals come over perpends. and that the broken bond, if any, comes under the sill.

Arches in general must have a total depth from the bottom of the springing to the top of the crown of a multiple of the depth of a course, to avoid cutting for a shallow course over the crown, which is never done neatly.

Relieving arches must spring clear of wooden lintels, taking their support from the brickwork only.

Rubbed arches must have all voussoirs exactly alike, and all with clean arrises. Mortar joints must be fine, and even in thickness. See that the soffit of a flat arch is cambered.

Rough arches must have all joints between voussoirs V-shaped and of the same thickness, and must not show a crescent-shaped joint between rings.

This crescent-shaped joint is usually due to the lowest ring dropping after the centre is removed, the cause of this dropping being that joints between the bricks forming this ring have not been fully flushed up.

A very common error is the solid bedding of stone and concrete sills. It is essential that sills and thresholds be "bedded hollow," that is, with a clear space of at least half an inch or, better still, a course of brickwork left out, underneath their centres to allow for settlement, due to weight of the jambs above. Unless this allowance is made, stone sills will break after a few months. The spaces left under the sills will close appreciably and must not be pointed up until the whole building is completed.

Chimney breasts, flues, and the backing of ranges and stoves afford the bricklayer his best opportunities of scamping work and using odds and ends of material: and it is in these places that good brickwork is specially required. Badly-built flues leak air, and will not draw, and rubbishy backing to stoves is a source of annoyance, and of expense also, when the grate requires to be renewed.

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Do not allow coke breeze concrete anywhere near a flue or fireplace —as often as not, it is inflammable.

Pay particular attention to the brickwork of chimney stacks, especially the flaunching. Being out of sight once the scaffolding is removed, it is often scamped, and the chimney pots are badly set. This may or may not be dangerous, but it will usually leak smoke, and the stack will become unsightly.

See, as far as you can, that pargetting is sound, and that the flue is cored as the work proceeds—*and that the core is not left in when the job is finished.*

Best practice in fixing joinery in brickwork completes the brickwork first and makes joinery to fit the openings. The practice of fixing door and window frames first and building the brickwork round them is becoming prevalent.

This is certainly quicker than the orthodox practice, and it is easier to make a close joint between brickwork and frame. There are no great objections to it, so long as care is taken not to use the frames as weight-bearing members. For this to be certain, some allowance must be made between lintels and the tops of the frames for settlement.

It may be remarked here that the use of door and window frames to support the brickwork above them, wicked as it is, is by no means rare. Hundreds of doorways in jerry-built houses have been, and are being, erected without lintels. The self-corbelling of brickwork will look after most of the weight until the frames require renewal, and when that day arrives the small triangle of brickwork immediately over the opening will probably stick up in place by force of habit.

MASON.

Comparatively little masonry work is now done in W.D. buildings, and it is easy to lose touch with it.

A few reminders of the essentials in masonry follow, but only the most frequent malpractices can be mentioned in a short article.

STONE.

It pays to look up all the information it is possible to get about the particular stone specified for use in a building. You must know your material before you can accept or reject it, and all the information you need is readily available in text-books such as *Rivington* or *Mitchell.*

It may be mentioned here, in particular reference to Portland Stone, that blocks should be washed before being placed, if they come ready worked from the mason's yard to the building. It is usual to whitewash such blocks with Whit-bed slurry after working, to protect the face ; and many a block of Roach-bed has taken the

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place of the finer and more expensive Whit-bed, due to the white-wash hiding its real character. A visit to the mason's yard to see the stone being worked is the best safeguard.

Natural Bed.

See that stones carrying weight have the natural bed normal to the direction of the stress. This is easy in most cases, but Bath and Portland and a few others do not show their beds clearly. Stones from these quarries are usually marked at the quarry with figures giving the cubic content of each block, and these figures are cut to read the right way up when the stone is resting on its natural bed.

An exception to the rule of bedding on the natural bed is made in the case of cornices with deeply-undercut mouldings. The pendant parts of such mouldings will flake off if the natural bed is horizontal —assuming that the cornice is horizontal. The stone must be so worked that the natural bed is vertical and at right angles to the face of the wall.

" Face bedding," which means that the bed is vertical and parallel to the face of the wall, must never be allowed.

This fault, though everybody knows about it, is very common, and it was committed even in the building of the Houses of Parliament with disastrous results.

Most of the useful supervision of mason's work, where wrought stones are used, is done before the stones are actually laid. Once a stone is laid it is almost impossible to replace it if a defect is noticed, without spoiling the appearance of the work. Similarly, chipped stones cannot be " invisibly repaired," so that arrises and mouldings must be protected until the building is completed. Stones accidentally chipped during preparation, or containing flaws, are often " repaired " by filling the hole with a paste made of stone dust and resin. This repair is difficult to detect, but it should not be allowed, as the patch will spall off from frost action in a short time.

Points to notice in the building of walls are :—

See that sufficient through stones are used, except in buildings intended for habitation, when long headers should be used instead, as through stones conduct moisture from outside to inside.

Do not allow any stone which is deeper at the front than the back to be used. Such stones will be packed up behind with spalls to level their tops, or filled up on top to make a level bed for the next course with rubbish and mortar. Anyway, the wall will not be solid.

See that each stone is covered by parts of at least two stones above, and that it overlaps parts of at least two below.

Try the tops and beds of wrought stones with a straight-edge to see that they are not hollow or hogbacked.

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SLATES AND TILES.

There is little to be said about this trade. See that the gauge specified is adhered to, tilting fillets put in, and torching properly done. This last will often be scamped in places difficult to get at.

CARPENTRY AND JOINERY.

The specification will contain an instruction laying down the quality of timber to be used, and the usual clause that the "timber used shall be free from large, loose or dead knots, shakes or defects of any kind, etc." This clause has been in use so long that a contractor would miss it dreadfully if it were omitted, but familiarity has had its usual result. Nobody takes any notice of the clause now; it has become hackneyed.

It will do no harm if you examine timber with one eye on this clause, but do not take it too literally.

Timber without knots cannot be insisted upon—there is none. All you can do is to see that it does not have too many and that none are loose or very big.

Small shakes do not matter, but cup shakes extending to a fairly large arc must not be allowed, *e.g.*, a cup shake which subtends an angle of 30° to the centre is a definite flaw.

Do not allow more than 10 per cent. of sapwood, and see that such sapwood as there is, is dry.

(Sapwood is the young wood on the outside of a tree, and it is very prone to decay, being porous and often sappy. It has much less strength than the heartwood.)

The following distinctions between good and bad timber are easily made:

Sound timber gives a sonorous clang when struck with a hammer; bad timber a dull thud. The sound of timber being sawn should be harsh and sharp and the edges of the cut should be clean. A timber which is beginning to decay will sound muffled when sawn, and the surface left will be woolly.

Run a plane over suspected timber, if it is good the newly-made surface will be faintly lustrous; if bad, it will show a dull chalky appearance.

In these days, owing to the enormous quantities used during the War, properly seasoned timber is very difficult to get. There is, therefore, all the more reason to give timber a chance to complete its seasoning in the building by seeing that it has plenty of ventilation. Even well-seasoned timber will rot if placed where it cannot have fresh air circulating round it; and if it is not well seasoned, it is already in a state favourable to decay, and must be specially well ventilated.

For this reason, the practice of laying floors directly on top of the

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concrete seal is bad. No concrete is waterproof; damp will soak up to the underside of floorboards in sufficient quantity to provide a favourable condition for starting rot, and the impossibility of providing ventilation under the boards will do the rest. If you cannot get the design altered, have boards coated with solignum on the underside and edges before laying, even if it entails an "extra."

(Similarly, linoleum, if well laid, prevents ventilation, and may cause rot. A wooden floor laid on concrete and covered with linoleum has a very poor chance of a reasonable length of life.)

Take care that floor and roof timbers are well clear of flues and fireplaces.

See that carpentry joints are correctly designed, *i.e.*, that compression joints *are* compression joints and not tension joints or scarfs.

Do not allow scarfing of purlins, except over supports, and not there if the purlin is calculated as continuous.

Examine doors and windows in the shop before the priming coat is put on. Putty has made up many bad joints, and it is not easy to detect after painting.

See that door panels fill the grooves, and that brads, fastening mouldings to framing, do not go through the edges of the panels, or the panels will split when shrinkage takes place.

See that joinery is protected from damage by workmen. Newel posts should be swathed in sacking, stair-treads should have a strip of wood nailed on to cover the nosings, doors should be secured open so that traffic is not impeded and dirty handmarks are not rubbed into the wood by constant opening and closing, and so that there is no danger of slamming by wind. Protect both the stone sill and the inside window boarding from workmen's boots. Workmen use window openings instead of doors and they suffer damage from such traffic.

PLUMBER.

The makers of sheet lead and lead piping usually mark the weight per foot super or foot run on the outside sheet or coil of a new lot. If this mark is missing, it will sometimes repay the trouble to weigh a sample. It requires a great deal of experience to distinguish 4-lb. from 5-lb. sheet by inspection.

Before laying lead flats and gutters the woodwork should be inspected to see that all nails have been punched home, so that none remain to puncture the sheet. Also, see that bearing timbers run across, and the boarding with, the flow; otherwise, the ridges which form when the boards warp may hold up pools of water. In any case, test flats and gutters with water to see that no pools remain.

See that soakers have their proper lap and that flashings cover the soakers. Wherever lead sheets, whether in flashings, drips, or rolls,

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lap over each other, see that they do not lie close to each other, except at the end of the overlap, or capillary attraction will cause water to soak up between the sheets.

When lead pipes are bent, look at the bends to see that they have not flattened.

Make very careful inspection of the connections between closet pedestals and soil pipes; and see that the flush pipe is not larger than the outlet from the cistern. It is better if slightly smaller.

Unless the overflows from baths and lavatory basins are contained in the fittings (as is usual now), make sure that the plumber does not connect the overflow to the waste pipe beyond the trap.

All water pipes must be fixed to a regular fall, so that if the system requires to be emptied for repairs, or during frosty weather, no dip will be left full. This precaution is doubly necessary in the case of a hot water supply system, to prevent accumulations of air which would collect in the top of a bend and cause noises or even stoppage of the circulation.

Notice details of hot water systems, such as the provision of a draw-off cock, which will empty the system without leaving a pocket full of water in the bottom of the boiler; the safety valve; and the expansion pipe.

The stop cock on the cold main must be inside the building and easily accessible.

Do not allow taps to be fitted on the ends of pipes or there will be trouble from water hammer. Taps should be fitted on a short arm at right angles to the pipe, and a few inches from the end.

See that all sanitary fittings, especially water closets, are filled with sand until the building is finished, to prevent workmen using them. A W.C. pan which has been used before the water supply is laid on can never be cleaned.

PLASTERERS.

The remarks on mortar apply equally to plaster, and there is in addition the hair which is mixed in to bind it together. If the hair is properly mixed, and in sufficient quantities, it should show like a fringe over the edge of a trowelful of plaster picked up and shaken so that the overhanging plaster drops off.

Where it is possible to see the backs of the laths, see that the plaster has curled over to form a key. It is not usually possible to inspect ceilings which have a floor over them, because it would be likely to cause trouble if a floorboard were lifted and then nailed down before the plaster had set properly; but bedroom ceilings can be inspected from the roof spaces.

See that the plaster is taken down to the floor level. Plasterers will try to avoid plastering the few inches which will be covered by the skirting, and a convenient home for vermin is left.

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Test the work, preferably before the setting course is applied, with a long straight-edge, to see that it is flat.

Keene's cement angles should have a Portland cement backing.

Portland cement rendering will always show fine " hair " cracks, due to the shrinkage on setting. To avoid this, the finishing coat should be worked up with about 20 per cent. of lime putty or plaster of Paris.

PAINTERS.

Paints are now nearly all purchased ready made, and their quality is a matter over which you will have little control.

Your interest is to see that the paint is applied as received, and not let down to make it cover more ground ; and that the specified number of coats are put on. Your best safeguard is to have sufficient difference in tints between all the coats. If two or three coats of the same shade are used you will be lucky if you get them all.

At the same time, you must not have great differences between tints, or the under coats will " grin " through if ever the work is knocked or has heavy wear.

Do not try the old dodge of making pencil marks with the idea that they will show if another coat is not put on. A fraudulent painter knows that trick at least as well as you do, and the only result will be that you will appear foolish in the eyes of the boy who follows you round with a brush to paint out your marks.

If Keene's cement is to be painted, it must be done as soon as it is hard enough to stand the brush.

Cement rendering will not take paint for at least twelve months, unless the natural maturing process is hurried up by washing the work with weak carbonic acid.

All steelwork, fall pipes, etc., must be painted before fixing, or hidden joists, the backs of cisterns, and spigot ends of pipes, will never be painted.

CONCLUSION.

Finally, when the builder quits the building, see that he removes all odds and ends of timber, bricks and other material, and that he fills in the lime pit, if any, and all other holes which may be a source of danger.

Pudlock holes should be neatly filled, holes where pipes came through wells made good, and the hollow bedding of sills can now be pointed up.

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THE OLYMPIA TANK MOUNTAIN.

By LIEUT. P. W. G. HUME, R.E.

THE task of designing and building a " Mountain " for tanks to go over, at the Royal Tournament at Olympia, was given to the 23rd (Field) Company, R.E., in the middle of February, 1926.

The requirements of the mountain were to take mules, tanks and dragons up to the height of the gallery (20 feet) and down again to floor level, in the breadth of the arena (80 feet). Owing to the structure encroaching on the arena, and having to be in position during the other displays for which it was not intended to be used, a limit of 13 feet width at ground level was imposed. A doorway, 16 feet wide and 13 feet high, was required, with doors, for the entrance to the arena in the centre, so that the door lintel would be a bridge taking all the mountain traffic. The cost was to be between £300 and £400. The mountain was first to be put up at Farnborough, to allow the tanks to practise, and then dismantled and re-erected at Olympia.

For the purposes of this article, it is not intended to give a complete account of the construction, but rather an explanation of the difficulties that arose and how they were overcome.

SLOPE.

(*a*) *Grip of track.* The capability of the tank of climbing the slope of 35 degrees was the first doubtful point. It was ascertained that the new Vickers tank would climb a slope of 45 degrees on a suitable surface, but nothing was known about its performance on timber. The track, on inspection, was found to present to the ground a surface to all intents smooth, with no part to dig into the roadway, and it therefore seemed probable that the steepest angle that it would climb would be the limiting angle of friction—steel to timber. *Molesworth* gives μ for this as ·6, giving an angle of 31 degrees, and so it seemed probable that the track would slip on the 35 degrees slope.

To test this, a short length of 35-degree ramp was made with sleepers, on Miles Hill, Aldershot, at the top of a hill slope of 20 degrees. The roadway was 2 sleepers wide, with 6 runners dug into the ground, and the decking spiked to them. The ramp represented the top 12 feet of the mountain slope, and was curved over to the horizontal at the top, with the corner rounded off. Theory proved

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accurate on trial, the tracks slipping just before the tank was completely on the ramp.

The first expedient for increasing the grip of the tracks was a series of spikes driven into the sleepers, leaving about one inch of each projecting. The result of this might have been foreseen ; the friction now became that of steel to steel, or less than it was before.

It was then realized that, if additional grip was to be supplied by steel, it would have to be in the track, and the roadway left plain. Small half-inch bolts were put in the track plates, one per plate, with the nuts towards the roadway, and this enabled the ascent to be made.

(*b*) *Impact.* Although the change of slope at the top of the ramp was fairly gradual, it was noticed that a good deal of bumping occurred when the tank went over it. This was principally due to the centre of gravity of the machine being behind the centre, with the result that it proceeded past the point of change of slope, still at the steep angle, and then crashed down on the gentler grade.

With anything but a very steady use of the accelerator, the tank started a wobble, which increased this effect.

Other factors affecting the amount of impact to be allowed for were that the tank might stop suddenly or start with a jerk on the sloping portions of the roadway, and that if any steering was done, great cross strains would occur in the decking, owing to the bolts in the tracks preventing free skidding. All calculations were accordingly made, using an impact factor of 2.

As regards the impact caused by the tank bumping down at a change of slope, this was most inconvenient at the top of the up slope, as it would occur at about the middle of the bridge span ; so the top 9 feet of the 35-degree slope was eased to 24 degrees, making two points of impact both less than the one previously. It was not possible to overcome the fact that the top point of impact occurred in the centre of the bridge span, because of the level length required at the top.

(*c*) *Wear.* The bolts in the tracks would evidently wear out the decking rapidly, and so it was decided to use 3-inch decking to take the weight, with 2-inch decking superimposed on it to take the wear, and be renewed if necessary.

(*d*) *Dragons.* As a tank could only just get up the slope with bolts in its tracks, it was obvious that a dragon with gun would be unable to do so.

(*e*) *Mules.* Two-inch chesses were nailed to the trial ramp at various distances apart, and mules ridden up.

It was found that 3 inches clear between chesses enabled them to be ridden up with ease, but later it turned out that the 35-degree slope had such an upsetting effect on their loads, that the mule could not climb up.

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DIMENSIONS.

(*a*) *Length.* After seeing the tank descending the trial ramp, it was decided that an easier slope would improve matters, and a straight run-off of 25 degrees was decided on. This meant a greater length of floor space would be required for the mountain, and it was arranged that 12 feet run of seating on either side of the arena would be removed to make room ; the value of the seating accommodation thus lost worked out at £2,000.

A removable ramp was to be placed as on right of Plate IV, to enable tanks to get on to the mountain from the arena ; the level portion at the top of this ramp was covered with cinders, to prevent the track bolts digging in and stopping the 90 degrees skid turn, which had to be made there.

(*b*) *Height.* Owing to the limit of width at ground level imposed (13 feet), the structure was necessarily rather top-heavy in the centre, where it was 20 feet high ; it seemed probable that some wobbling would take place when the tank got near the top, more especially as the tank would weigh at least three times as much as the portion of the structure immediately beneath it, and would be a live load.

It was found, however, that the ground sills of trestle piers could project underneath the gallery and so increase the base width of 13 feet.

(*c*) *Bracing.* Looking at the mountain in elevation, it is seen to consist of two main portions, connected by the bridge span over the door, so that there could be no effective cross-bracing between these parts. So each ramp would have to be made absolutely firm to act as abutment to the bridge span. To help steady the mountain, two pillars (supporting the roof of Olympia) might have been utilized to tie trestles to, but as they would not be there at Farnborough, they could only be looked upon as an additional help.

(*d*) *Roadway width.* The width of the roadway was intended to be about 12 feet in the clear.

The width of the tank, from outside to outside of tracks, was measured as 8′ 8″, which, with a 12-foot roadway, would allow the tracks to " wander " over about 3 feet.

Preliminary calculations having shown that timber roadbearers were out of the question, owing to there not being enough room for them to be lap-jointed over the trestle capsills, R.S.J. roadbearers were decided upon. It became apparent that the roadway width might well be reduced, giving the following advantages :

1. Fewer joists required to cope with the " wander."
2. In the event of a track breaking, the tank would hit the ribands earlier, before it had gained much slewing momentum.

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3. There would be less chance of a track riding up on a riband, owing to the tank being kept at a more oblique angle to the ribands.

A width of 9′ 6″ in the clear was fixed, allowing only a total of 10 inches to spare.

Design.

(*a*) *Roadbearers.* As these would evidently be a large item in the total expenditure, every effort was made to avoid buying joists. Some 12″ × 5″ joists, 22′ long, part of some old bridging equipment, were found to be available at Chatham, and suitable for the main joists of the bridge span. The only other useful size available was 8″ × 4″, 16′ long, and these were used for the removable ramp and the level span at the top. For the sloping ramps, some 8″ × 5″ R.S.J.s were bought ready cut to the required lengths.

The maximum unsupported span for any of these joists being taken as 8 feet, one would take the weight of one track, allowing 100 per cent. impact. Two of these joists were accordingly put to support each half of the roadway, placed under the two extreme positions of the tracks.

The method to be employed for fixing the R.S.J.s to the trestles provided an unusual problem, as slopes of 35 degrees are hardly likely to be met with in heavy bridges. The bearing between the joist and the trestle had to be such that it would transmit the weight normal to the joist, the component along it, and the additional force along the joist due to the tank starting or stopping with a jerk. An acute angle on the lower flange being too costly, a normal equal angle, 4″ × 4″ × ½″, was used, to butt up against a shaped capsill-piece on the trestle; the joist would rest on the capsill-piece also (Plate 1).

The joists would, where possible, run over three trestles, making a length of joist of about 19 feet; by inserting packing, the angles could be made to distribute the thrust from the joists equally on to the trestle capsills, or in any required ratio.

To stiffen the joists, on most of the spans the angles were continued across each pair of joists, similar angles being put across the top flanges to take the thrust of the decking. To make the angles serve yet another purpose, in some cases additional ones were put on at the lower side of the capsill-pieces, so that the joist would both strut and tie the tops of the trestles. The joists, spanning two bays where possible, were placed so as to break joint on the down slope.

The decking was kept from slipping down the roadbearers by the angles on the top flanges, but the chesses could not be actually fixed to the joists in any way; so between each pair of joists an 8″ × 4″ timber roadbearer was spiked to the capsill-pieces, and the decking nailed and spiked to it.

(*b*) *Trestles.* The special point in the design of the trestles was

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that they would have to be dismantled after erection at Farnborough in order to be taken to Olympia.

This meant using the split-sill design for all trestles too large to be carried whole. The three centre trestles were made of this type, as they were of 8″ × 8″ timber and weighed about 1½ tons each. The remaining trestles were of 6″ × 6″ timber, and as the largest only weighed half a ton, it was decided that they would be carried complete, and they were spiked and dogged in the usual manner.

Plate III shows the split-capsill and -groundsill design of trestle, with bolted joints throughout.

The chocks on the ends of the legs, to transmit the weight from the sills to the legs, were 2′ long and spiked on. The end of each leg was cut to a 4″ tenon, leaving a 2″ shoulder on each side, so that the chocks had to be of 2″ stuff. It was calculated that with the arrangement of legs shown, the two legs together at points where weight was taken were more economical than using legs of 12″ × 12″, made the parts easier to handle, and gave a longer bearing for the sills on the legs. The space between the legs was for the heads of the bolts taking the cross-bracing to the next trestle.

It will be noticed that no rakers could be used on the arena side of the trestles, owing to the limited width allowed. The timber used for all trestles was British Columbia pine, costing 4s. a cubic foot.

(*c*) *Door span.* The 12″ × 5″ × 22′ R.S.J.s from Chatham were to rest on the two large trestles, and left some 4 feet spare on one end. As with the sloping joists, angles were put across the lower flanges to stiffen joists, and were packed up to the capsills with double wedges, so as to strut and tie the trestles and help to stiffen the connection between the two main parts of the structure.

For superstructure between these joists and the roadbearers, crib-work was expensive, and trestles too small to make bracing effective, so, as dimensions were favourable, steel cubes were used. Each cube rested on two timber bearers running across the large joists, and there were similar bearers on top of the cubes with the roadbearers resting on them. Bolts and spikes were used for fixing. The detail of bracing for the cubes was left till the actual erection.

As any thrust along the sloping joists of the top spans would have an upsetting effect on the cubes, for which it would not be easy to provide in the fixing down, the packing of the angles at the top of these joists was made slightly looser than elsewhere, so that any thrust along the joists would be taken by the trestles rather than by the cubes.

(*d*) *Longitudinal cross-bracing.* There was no means of calculating the size or amount of cross-bracing required between trestles, and it was decided to have three complete X's in each bay, and three runners along capsills and groundsills. 8″ × 4″ was used for all bracing of the large trestles, and 6″ × 3″ for the 6″ trestles.

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In the case of the large trestles, the holes for the bracing bolts had to be augured and the bolts inserted before the trestles were put together, so the positions of the braces had to be worked out for all the trestles from sketches. The positions of the braces were not the same for all the trestles because the legs varied in position, according to the roadbearers above, which overlapped on the capsills.

(*e*) *Removable ramp.* This ramp, taking the tank up the first 6 feet on to the level span, had to be removable as it encroached on the arena, and would only be in position for the one display at the Tournament.

The 8″ × 4″ R.S.J.s from Chatham were used for roadbearers, the top ends being cut off at half the angle of the slope, the end pieces turned over and bolted on to the remainder with two ⅜″ cover plates. The top piece then rested flat on the capsill of the first trestle. Four joists were used, in pairs with angle pieces across them to stiffen them and take the thrust of the decking, and to transmit the thrust to the groundsill.

The " unit " formed of two joists and their angles weighed 576 lb., and so could easily be placed in position by 8 men. The decking for this ramp was 4″ thick, to allow for wear without replacement. No ribands were used, in order to save time in putting the ramp in place.

Construction at Farnborough.

A suitable site for the erection having been chosen in Pinehurst Barracks, a foundation of sleepers running longitudinally as mudsills was laid down and levelled. Time being rather short, it was decided to get the large trestles up without putting up a derrick if possible. The two trestles of the bridge span were built with their groundsills roughly in the correct position, and the tops of the legs resting on steel cubes so as to give the initial lift. The groundsills were strutted apart, and footropes taken back to picket holdfasts, while a 3–2 cordage tackle was put between the capsills. Two headropes were taken back from each trestle to holdfasts. From a scale drawing, it was found that the initial pull on the tackle would be rather greater than the weight of one trestle, probably 2 tons. No 3″ cordage blocks were available, and a 2″ tackle had to be used, thus straining the cordage to the full 2C[s].

A tank was put on the end of the fall, to save man-power and as many men as possible got round the capsill of one trestle, which was raised by the tank till just short of the vertical. The headropes of this trestle were now checked and the pull continued, now raising the other trestle.

As soon as both trestles were up, the groundsills were levered into their exact positions, and squared off with the centre-line of the mountain; the trestles were then braced together. The third large

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trestle was built with its head away from the other two, and raised by the tank in a similar manner.

The remaining trestles were easily erected by hand.

It should be mentioned here that, prior to the erection at Farnborough, preparation of material had been going on for some time: the 6″ × 6″ trestles were made at Farnborough, and the parts of the large trestles; the R.S.J.s to be used were drilled and the angles prepared in the shops at Aldershot. The drawings of the trestles and joists were got out, taking dimensions from a large drawing showing them together, and it followed that there would have to be a good deal of cutting and packing in fitting them all together. Actually, there turned out to be surprisingly little. As in the case of the large trestles, the bolts for the cross-bracing were put in these trestles at the time of building them.

Before the large joists of the bridge span were got up, it was seen that the angles to be fitted across their lower flanges would catch the nuts of the capsill bolts, and so a 1½″ × 12″ board was cut and nailed along the tops of the two trestles to pack the joists up. In order to minimize departure from the drawing, the 8″ × 6″ cube bearers were cut down to 8″ × 5¼″, to bring the height of the decking of the top level span the same as on the drawing.

The 12″ × 5″ R.S.J.s were got up as soon as the trestles were sufficiently braced to take them. The joists were raised by tackles attached to spars on either side of the gap.

The spacing of the joists in threes made it impossible to bolt each cube bearer to more than four of the joists, and made some of the bolts holding the angles to the lower flanges very difficult to put on.

The cubes were slid up the joists of the "up" ramp when these were in place, and fixed to the bearers with spikes and coachscrews, using as few as considered safe, to facilitate dismantling.

The 2″ decking did not arrive in time for this erection, and so the 3″ was used alone, nailed through to the timber roadbearers. It was found, when the decking had been laid, that it was impossible to walk up the 35 degrees slope, the 25 degrees being just possible.

The ribands consisted of two sleepers laid one on top of the other and bolted right through to the top flanges of the roadbearers.

Tank Ascents at Farnborough.

For the preliminary ascents the removable ramp was placed in prolongation of the mountain in order to give the driver of the tank no greater task than necessary to start off with. Plate IV shows the mountain completed, but with the removable ramp in the correct position; the two spars at the top were to act as a guide for the driver, while ascending, as he could not then see anything except sky.

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The first ascent was watched with bated breath, but was entirely successful; there was quite a distinct sideways wobble of the whole centre portion of the mountain, when the tank landed on the level bay at the top (Plate III), but otherwise all was well. The descent was done very slowly, especially near the top (Plate IV). The time taken from ground to ground was 2½ minutes, the tank's lowest gear being used.

It was thought advisable to put higher ribands on the top bays, as the tank might bump down on one when going over a point of change of slope. An extra sleeper was put on the other two, on the four top bays, and a 4″ × 6″ angle-iron riband spiked on top of that, making a total height of 21″. During one ascent a track actually did mount a riband, but the driver noticed the guide spars moving sideways and corrected the course!

The removable ramp was next placed in its correct position as in Plate IV, and the level span covered with cinders; but it was found to take five minutes to turn through the 90 degrees, which would be too long for the display, and permission was got to leave the removable ramp in prolongation of the mountain.

The ascent of the first 6 feet on to the level span was the most spectacular part of the whole performance (Plate V).

All parts of the structure were next labelled in order to recognize them on re-erection, a fairly elaborate system being necessary.

It took one full week, from the time that the first trestle was laid out on the ground till the tank made its first ascent, the average number of men employed for this period being 30. It was completely dismantled by fewer men in 2½ working days, and stored in a hangar.

The Strike occurred about the time the mountain was erected, and the Tournament was postponed for six weeks.

During this time, various odd jobs were done, such as the bolts run down and the doors made.

The construction of the doors is perhaps worth mentioning, as they were of quite a considerable size—7′ 4″ wide by 11′ high. They were made of framing of several sizes of timber, but all having a 4″ dimension, which was in the thickness of the door. There were three main rails of 4″ × 3″, to take the hinges, with two diagonals of the same size between them. The remaining space was filled in with 4″ × 1½″, so as not to leave more than 1′ 6″ between parts of the framing, and three-ply was nailed on both sides. The result was a fairly light door for its size, but heavy enough to make slamming impossible.

Transport to Olympia.

This part of the work was not without its excitement. Altogether, some 12 tons of steelwork and 30 tons of timber and stores had to be carried to London.

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The most difficult load was the two largest 6" × 6" trestles, which were respectively 10 and 11 feet high. They were mounted on a 4-ton lorry, with their capsills tied together and groundsills at either side of the lorry's body. The overall height of this load was 15' 6", and the lorry was unable to get under Staines Bridge, and had to go some way round to avoid it. One load of timber, stacked rather high on a Sentinel steam wagon, caught fire twice on the journey from sparks from the smoke stack.

ERECTION AT OLYMPIA.

This proved a good deal easier than at Farnborough, as the pillars supporting the gallery were used for taking the lifting tackle for the large trestles, though there was rather a lack of holdfasts for foot-ropes.

Although the concrete floor was a much more even surface than the sleeper foundation had been, most of the bracing fitted without re-auguring.

All joints were made stronger at this erection, all the bolted joints being spiked and/or nailed in addition. Some stout bracing was put across the cubes, and successfully checked the sideways wobble. The L.C.C. representatives would not allow any part of the structure to touch the pillars or gallery, so that no steadying could be got from them as was originally intended, but the wobble did not now exceed an eighth of an inch during any part of the tank's journey.

The guide spars were dispensed with, as the roof of the building gave the driver sufficient indication of his course.

The 2" decking was put on in this erection, chesses being spaced 3 inches apart. The spaces between the chesses were filled in each side, where the tracks came, with chocks, to make the roadway more solid, as this decking was for the most part only nailed to the 3" decking underneath.

A light removable ramp was made to get troops and light field guns up on to the level span, and this was placed at right angles to the mountain.

On completion, tan was filled in underneath the structure to make the base more solid, and to deaden vibration.

Time for erection. The mountain was erected at Olympia by 22 men working for 6 days, making a total of 1,184 man-hours worked, which included unloading the lorries.

Cost. As soon as the design was got out, an estimate of the cost came to £500, and this was allowed.

The actual total cost, including transport, was £480, of which £305 was timber and £114 steelwork.

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THE OLYMPIA TANK MOUNTAIN.

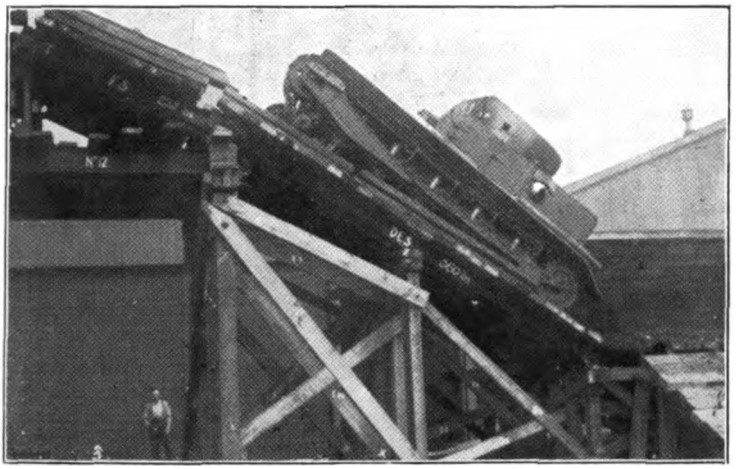

Plate I.

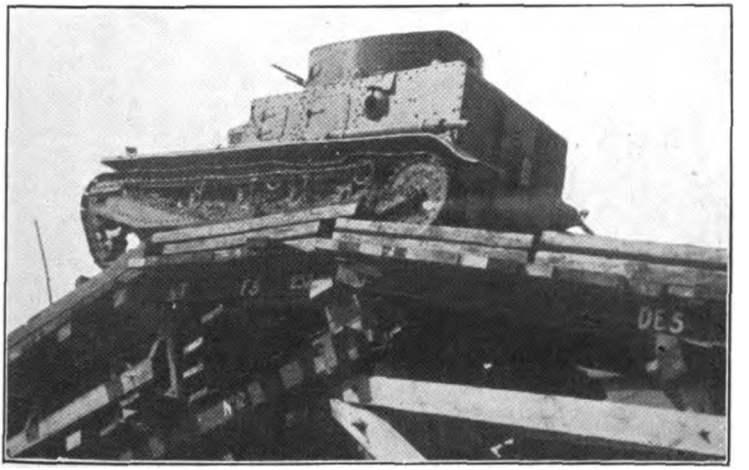

Plate II.

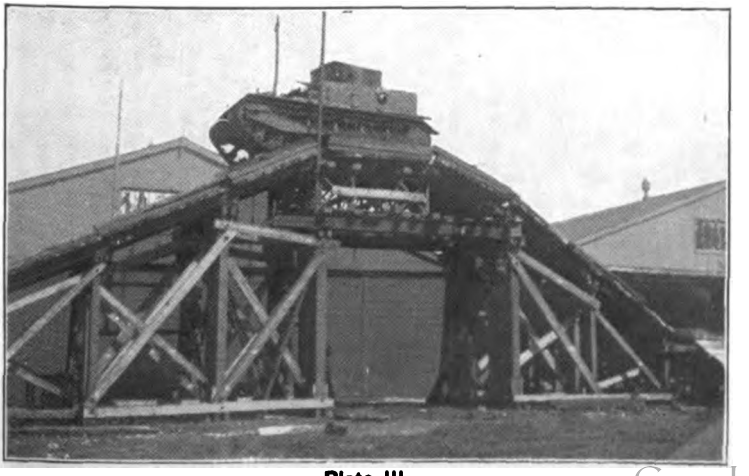

Plate III.

Photographs by Gale & Polden, Aldershot.

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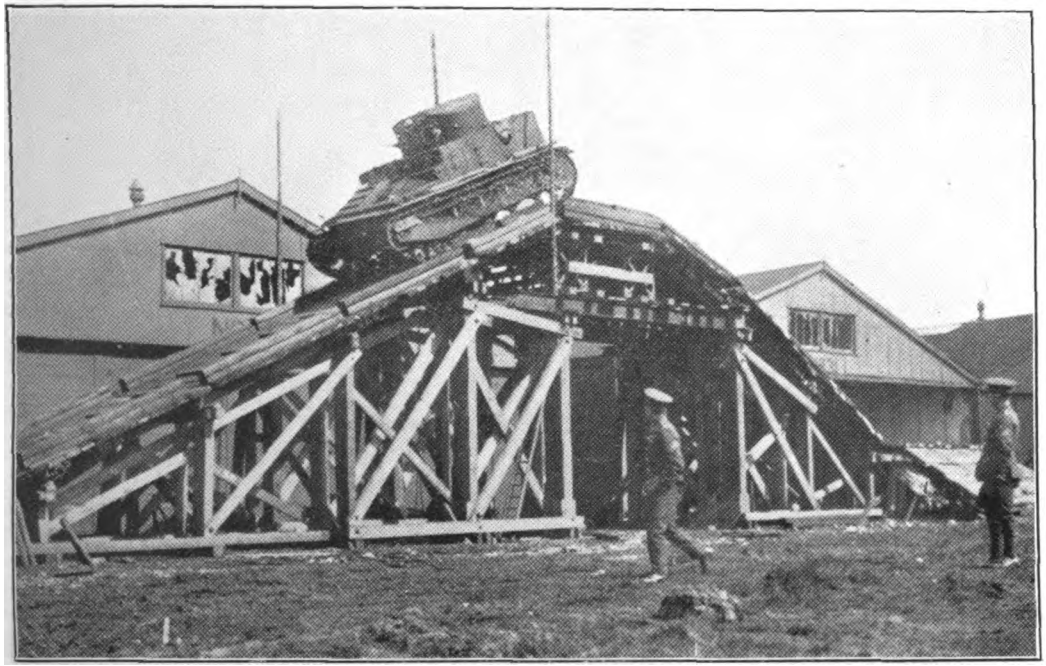

Plate IV.

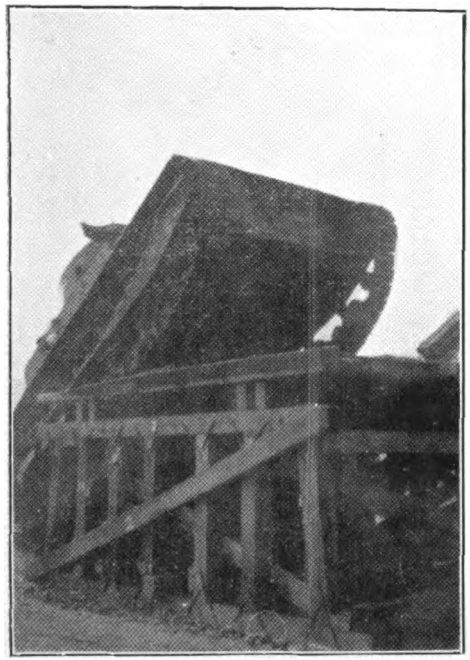

Plate V.

Photographs by Gale & Polden, Aldershot.

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IMPROVISATION IN NORTH CHINA.

By LIEUT. J. V. DAVIDSON-HOUSTON, R.E.

INTRODUCTION.

BETWEEN the middle of April and the middle of May, 1928, the writer was employed on the following tasks at Wei-Hai-Wei:

(1) Preparation of Ma T'ou Barracks, at Port Edward, for the Convalescent Depot.
(2) Adaptation of the old Coolie Depot, at Tung Shan, for the reception of an infantry battalion (less machine-gun company).
(3) Preparation of a site at Huai Shu Ti for a machine-gun company and machine-gun range.
(4) Construction of a rifle range at Tung Shan.

A complete description of the work would be out of place in the *Journal*, as the preparation of camps is one of the commonest duties of the Royal Engineers. It is proposed, therefore, to touch only on those points where the normal practice was departed from, owing to the rapidity with which the work had to be done, to the use of native materials and labour, or to the necessity for improvisation.

1.—MATERIALS AVAILABLE.

The following are the only materials to any extent used in Wei-Hai-Wei territory: (*a*) Bamboo matting. (*b*) Stone. (*c*) Timber. (*d*) Metal.

and the greatest of these is matting. This consists of squares of woven bamboo fixed to a framework of China fir poles, and was used wherever temporary shelters were required and there was no risk of fire. In Shanghai, it is possible to obtain a practically waterproof material made of paper sandwiched between two thicknesses of matting, but in Wei-Hai-Wei, it was necessary to cover the roof with felting in order to resist the penetration of heavy rain. The Chinese are adepts at the art, and can erect almost any type or size of mat building in two or three days, provided there is a sufficiency of labour on the job. Such structures are strong enough to resist the ordinary climatic conditions of North China.

Stone is the most commonly used building material, and is quarried locally in slabs up to 12 feet long. It consists largely of red and grey granite, and is frequently cheaper to use than wood. The timber is all imported, and consists of Oregon pine and China fir. The former is, of course, more expensive, and good enough for most work; the

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latter is badly seasoned and full of knots, but is readily obtainable at short notice, as the local contractors hold large stocks of it. Metalware, such as bolts, nuts, and water supply fittings, is entirely imported, as the local Chinese use practically no metal in their buildings.

2.—LABOUR.

Work was carried on through two term contractors, the reason for this strange situation being that one was only capable of undertaking carpenter's work, while the other was in a position to obtain water supply fittings from Chifu, up the Coast.

Neither contractor could speak, read or write English, and each one employed an English-speaking agent. One of these was unfortunately entirely ignorant of all engineering or building processes. A Chinese will make a verbal contract and as a general rule, will not go back on it, which facilitated matters, as it was possible to do much of the paper-work after the construction was over. In common with his *confrères* all over the world, he is prepared to put in inferior work if allowed to. The Chinese labourer is a cheerful and hard-working soul, and takes a pride in his work. Weather, however, easily upsets him, and as he frequently possesses only one suit of clothes, a sharp shower in the morning will often put him out of action for the rest of the day.

Masons are available in large quantities, and can undertake concrete and brickwork if required. It is noticeable that they will always hand-pack stones most carefully even when laying hard core for floors.

Carpenters are few, and as the work of all trades is carried out by hand, timber construction is slow and wants continual urging on.

Smithing is well carried out, both in iron and copper, but smiths are few. As the supply of water is entirely by well, cart and bucket, no plumbing work can be done, and all water supply fittings and experts must be brought from Chifu or Tientsin.

The supply of coolies is practically unlimited, and such labours as digging and filling can be carried out with remarkable speed.

3.—WELL BORING.

The camp site at Huai Shu Ti lay on a sandy waste between the hills and the sea, and was reached by a cart road from Port Edward, four miles away.

In six weeks, the following had to be done :

(*a*) Ascertain whether sufficient water could be obtained from a well sunk on the camp site.

(*b*) Discover what other resources could be drawn on.

(*c*) Make the necessary arrangements for the supply of water from whichever of these sources turned out to be practicable.

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As the supply from the neighbouring wells was not satisfactory, as regards either quality or quantity, and as the carriage of water from Port Edward would prove very expensive, it was resolved to go on trying for water on the camp site till the last possible moment.

The following information was available:

(*a*) The remains of an old filled-in well were found on the site.

(*b*) Owing to the drought, all the water courses were dry, and the native wells throughout the Territory were getting low.

(*c*) The Chinese said the sand was 20 or 30 feet deep.

(*d*) The only boring plant available was an old jumping-bar machine at Chifu, which had been previously used in boring artesian wells near Port Edward.

(*e*) An artesian basin was said to extend under a large part of Eastern Shantung.

(*f*) There had never been a geological survey of the district.

The boring plant was ordered by telegram from Chifu on the 20th April, and arrived on the site by the 25th. On the morning of the 27th, the oil engine was started up and boring began. By the afternoon, the tube had already sunk 20 feet, and some water was brought out. By the time 30 feet had been reached, however, the water disappeared, showing it to have been merely a small surface supply, and boring was ordered to continue.

As bad luck would have it, the tool struck a slanting rock at 33 feet, and could not be persuaded to penetrate it. It was impossible to tell whether this was a tilted stratum or an isolated stone, so there was nothing to be done except lift out the whole tube and start again somewhere else, and by the 4th May the plant had been re-erected on a spot about 150 yards further along the cart road.

At 24 feet, black sand and traces of water were encountered. This was again only surface moisture, and at 50 feet the bore stood in a clay stratum with no water in it. On the 7th, water was struck at 72 feet, and rose to within 25 feet of the ground level; later this rose to 20 feet. A test indicated a small yield, however, so boring was continued down to 90 feet, where rock was met with. The clay had by this time become more sandy, and the water was very cloudy.

The contractor announced that he could bore no further. "The machine is roo-ined, you see," was his explanation. It was found that the tool had broken itself on rock, and could not be replaced within a month, so the well had to be taken as it stood.

A small hand pump was obtained from Chifu by the 13th May, and coolies were set to pumping the well for several hours a day. This enlarged the water-bearing cavity at the bottom, and the yield improved slowly. At first, only 156 gallons were obtained in 2½ hours, by which time the bore was empty, and took 40 minutes to refill. Later, it was found that about 35 gallons an hour could be relied on, and by the 5th June, 800–1,000 gallons were being produced

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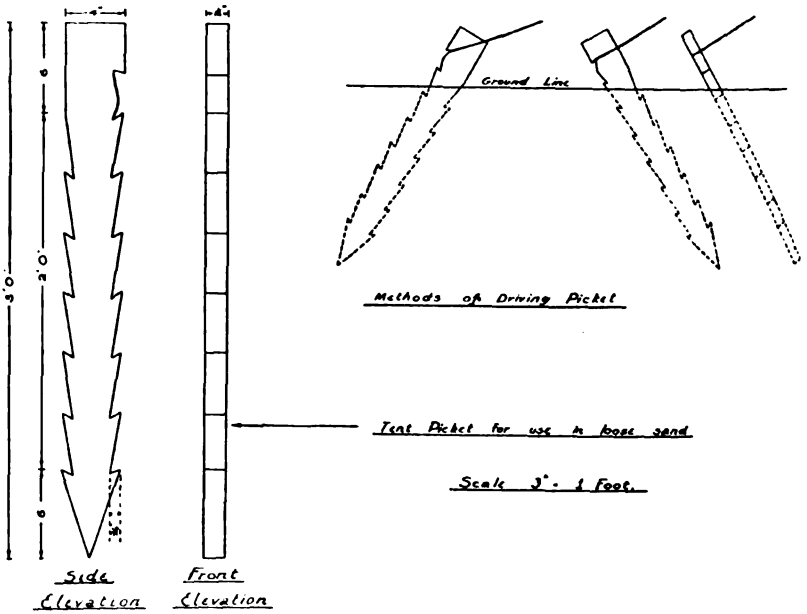
in the 24 hours. A hand-worked beam pump was eventually sent from Tientsin, and was operated by shifts of coolies. The water was slightly coloured by suspended matter, but was good to drink.

Tribute must be paid to the Chinese crew of the boring plant. Suited, as the Chinese seem to be by nature, to tend engines and cover themselves with oil, they maintained in working order the most unreliable-looking piece of machinery that has ever been seen.

4.—HOLDFASTS.

Considerable anxiety was expressed as to whether tents could be made to stand up in the loose sand at Huai Shu Ti, and as the tent



pegs issued were obviously useless for the purpose, orders were received to devise some other means.

In the interests of economy and simplicity of use, it was evident that the normal method of pitching tents could not be interfered with, and that something which could be used in the same manner as a tent peg, but with much greater holding powers, and ability to be produced locally by hundreds, would have to be employed.

These conditions ruled out picket holdfasts, buried holdfasts, and screw pickets. A barbed picket was then considered, and two samples made. Sample No. 1 consisted of a piece of ash 2½ in. x 2½ in. in cross-section, each of the four edges being notched in several places. Although three feet long, a trial showed that a direct pull with one arm would easily remove it from the sand. Sample No. 2 required a strong direct pull with both arms to remove it. Sample No. 1 was rejected.

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Sample No. 2 was driven into the ground in three different ways, to see which method would take the pull of the tent rope most satisfactorily: (*a*) The picket in prolongation of the line of the tent rope. (*b*) The picket at right angles to the line of the rope, with its edge towards the tent. (*c*) The picket at right angles to the line of the rope, with its face towards the tent.

As a result of tests, method (*c*) was adopted, and proved efficacious. No wind ever caused a picket to be pulled from the ground. The barbs were retained, as it was noticed that the picket moved in the direction of its length when considerable force was exerted on the tent rope.

5.—Cookhouses.

Cookhouses for officers' and serjeants' messes were required both at Tung Shan and Huai Shu Ti, and a type design was therefore evolved. The governing factors were:—(*a*) To be reasonably weatherproof. (*b*) To be cool. (*c*) To have adequate ventilation. (*d*) To be reasonably safe against fire. (*e*) To afford protection from direct rays of the sun. (*f*) The style of building not to be more costly than that for a standing camp. (*g*) To be flyproof.
Conditions (*a*) and (*d*) ruled out bamboo matting, (*b*) prohibited the use of corrugated iron, while (*f*) prevented the employment of brick or stone.

The design finally adopted entailed a double-roofed structure of half-inch boarding on a timber frame. The top roof was covered with felting, while a square opening was made in the lower one to allow the escape of hot air. Window openings (no glass) were made in each of the three sides, while a flyproof door was fixed in the fourth (leeward) side.

Shutters were provided for the windows in case of inclement weather. The window frames and the gaps between the two roofs were covered with flyproof gauze. These cookhouses were pronounced by units to be the coolest places in the camps.

6.—Rifle Range.

The site of the range having been chosen by the General Staff, the work required was divided between: (*a*) The butts. (*b*) The firing points. (*c*) The targets.

(*a*) The only possible place for the markers' gallery was behind the rampart of an old Chinese fort, as otherwise the necessary earthwork could not have been completed in the time. This, then, was the reference point which determined the positions of all the other parts of the range. The ground behind the rampart rose to a sufficient height to form a stop butt at certain ranges, but in many cases the bullet passed over it into the sea, to the imminent peril of those that went down to it in ships.

The design of the gallery and bank was adapted from that in

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Small Arms Training, Vol. III, and a wooden profile was erected in a gap in the rampart, so as to indicate the extent to which additional building-up was required.

(*b*) The positions of the firing points were then selected. Two main difficulties had to be faced. One was that at certain ranges the butts lay in dead ground, necessitating the building up of an earth bank or a wooden platform in order to see the target, and the other was that some of the firing points lay in the neighbourhood of nullahs, native graves, or cultivation. Instructions had been given that the country should be disturbed as little as possible; consequently all the firing points could not be sited in a direct line with the targets.

On a certain day, while considering these problems, the writer was approached by a farmer and an interpreter, who said: "My client is a poor man, and has no occupation. He has a numerous family. He is the tenant of the land on which you build the rifle range, but he will not ask for compensation if you will let him have the swill contract." He was referred to O.C. Troops.

The 500 yards firing point almost coincided with the officers' mess, which had been erected last year, thus adding one more to the conveniences already installed.

(*c*) A means of lowering and raising targets had to be devised, as the "Hythe Pattern" frame was, of course, unobtainable and only local resources could be drawn upon.

The "windmill" method, referred to in *S.A.T., Vol. III*, was undesirable, as eight targets were required, and that system would have necessitated an undue length of gallery.

It was decided to connect the pairs of targets by cords passing over pulleys, supported at the requisite height from the ground. A trial gantry was put up, and demonstrated the system to be satisfactory, but showed the following defects:

(1) Much friction where the cords passed over the pulleys, causing the targets to stick and the cords to come off the pulleys.
(2) The target would frequently strike portions of the gantry and become wedged.

The whole secret of smooth running was found to lie in the way the pulleys were fixed. The correct method turned out to be hanging the pulleys loosely from a beam, and not to fix their axles rigidly. Triangular fenders were also screwed to the sides of the gantries to prevent the targets sticking as they went up or down. The target frames were subject to considerable stresses, especially in wind, and had to be made extra strong.

When asked to comment on the finished range, a Company Commander remarked: "Very sporting course."

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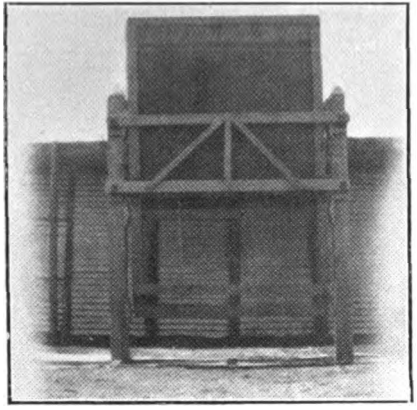
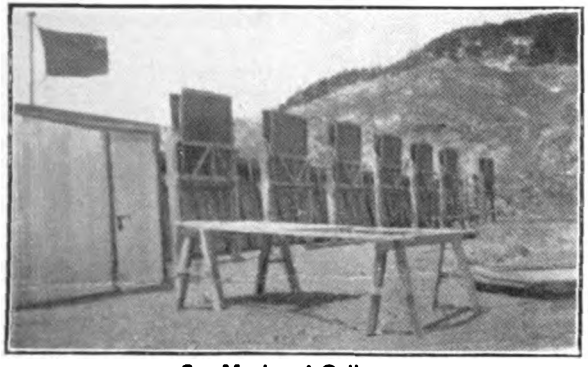
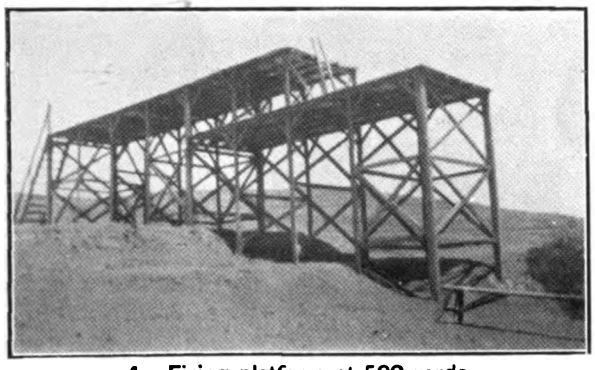
1.—Revetting the bank.



2.—Improvised Target Gantry.



3.—Markers' Gallery.



4.—Firing platform at 500 yards.

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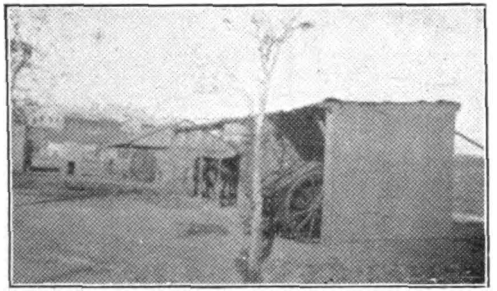
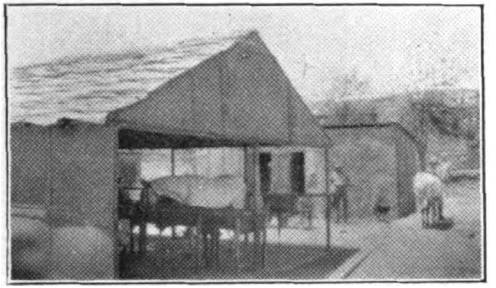
IMPROVISATION IN NORTH CHINA.

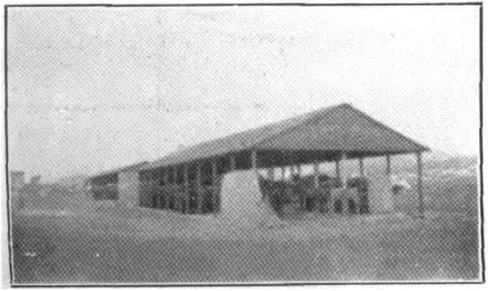
5.—Lorry Shelter.



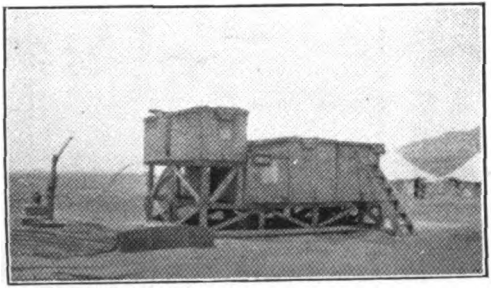
6.—Stables for Field Company Section, R E.



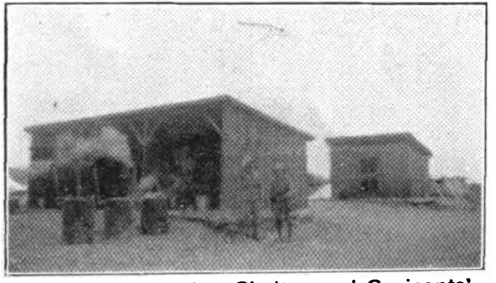
7.—Stables for Battalion, less M.G. Co.
(Writer's Chinese "charger" on the right.)



8.—Stables and Vehicle Shelter for M G Co.



9.—Water Point.



10.—Men's Cooking Shelter and Serjeants' Mess Cookhouse.

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THE DEMOLITION OF A PYRAMID.

By LIEUT. G. R. MACMEEKAN, R.E.

ABOUT 500 miles south of Khartoum, the country on both sides of the White Nile is inhabited by primitive negroid tribes, known collectively as Nuers. These tribes are at present wholly uncivilized. They are also extremely treacherous. Owing to the entire absence of communications away from the river, administration of the area has always been a problem of great difficulty, and although wonderful work has been done by a handful of isolated District Commissioners, our control over the tribes is still somewhat nominal, the real power in the land lying with various witch doctors.

Throughout 1927, it was known that there was a good deal of unrest among these savages. Various acts of insubordination were reported, culminating in open defiance of Government authority, and, towards the end of the year, it was decided that military operations should be undertaken with a view to re-establishing the prestige of the Government and giving the recalcitrant tribes a really good lesson.

At first, it was thought that punitive measures would be confined to the area east of the Nile. In December, however, Capt. T. Fergusson, District Commissioner of a large area to the west of the Nile, was treacherously murdered, and this necessitated a considerable extension of the theatre and general scope of the operation.

Actually, there were two distinct columns and, except for the formation of a common base at Malakal, their operations were in no way connected, the areas involved being widely separated, and the tribes implicated being totally different entities although all coming under the collective title of Nuer.

Those operations against the assailants of Capt. T. Fergusson were carried out on the west bank of the White Nile, and consisted mainly in drawing a cordon of troops round the swamps in which the enemy had vanished, and bombing the scattered islands on which they had collected with their cattle with aeroplanes, until their resistance was crushed and they surrendered to the cordon.

The other operations were directed against the followers of Messrs. Gwek and Pok, two Nuer witch doctors, who had a considerable local following on the east bank. Mr. Gwek had been fortunate in having a particularly successful magic season, having skilfully claimed the credit for arranging an eclipse in November, and the death of the

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District Commissioner's best pony from " fly," in the same month. This greatly increased his prestige, and when he was able to persuade his adherents that the Denk-Kurs Pyramid had been emitting blue smoke, a sure sign that the days of the foreigner were numbered, he announced his intention of murdering the District Commissioner and advancing on Malakal, the Headquarters of the Province.

While his followers were thought to be reasonably few, there was always the risk that any initial success on his part might bring in the rest of his section of the Nuers, the Lau, who were reported to be able to raise 20,000 spearmen and a number of ancient muskets variously estimated at from 200 to 5,000. Accordingly, a force of one company M.I., two companies Infantry and half a platoon of the Sudanese Field Company, all native troops of the Sudan Defence Force, with four aeroplanes from the R.A.F., were sent down to deal with him.

The grand finale of the expedition was to be the destruction of the pyramid, thus destroying Gwek's last claim to importance, and demonstrating the superior magic of the Sudan Government in general and the Engineer troops in particular.

The Denk-Kurs Pyramid, erected about 50 years ago, as the tomb of a Nuer witch doctor of unusual potency, was made of mud and reputed to be 60 feet high. Nobody in recent years appears to have seen it, but a rather poor photograph was discovered in an ancient number of *Sudan Notes and Records* (the photograph, by the way, was taken by the late Lt.-Col. Hugh Pearson, R.E.) from which it appeared that the diameter of the base was about twice the height.

The problem of blowing it up proceeded to cause much deep thought on the part of all concerned. The text-books preserved a strong silence on the subject of pyramids; the only useful information to be obtained was that gelignite was a most unsuitable explosive for the job, and gelignite naturally was the only explosive available in the country. The only help or sympathy received from the staff was a lurid picture of the consequences which would result from failure, when the assembled Nuer chiefs, called to witness the destruction of their holy hill by the superior magic of the Government, saw it still standing placidly as before.

Accordingly, it was decided that some sort of experiments must be made. A mud pyramid, 6 feet high, with 12 feet square base, was made in Omdurman, one foot height being laid per day to give the mud a chance to dry, this being roughly to a scale of 1/10th. Much poring over a cross section of the alleged shape of the pyramid, and treating it variously as an undercharged mine, an overcharged mine, a brick wall 35 feet thick, a bridge pier 60 feet thick, and various other ways, and putting in odd corrections for the probable effect of gelignite in highly fissured earth, produced an answer of 900 lb. for the actual pyramid. As all formulæ seemed at some points to bring

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in L.L.R[2], it seemed that 9 lb. would be the right amount for the 1/10th scale model.

Accordingly, a charge of 9 lb. was placed on the centre line of the pyramid one foot from the ground level (a shaft had been left for the purpose), the shaft securely tamped, and the charge touched off. The result was most gratifying; one of the more senior spectators was partially stunned by a lump of mud at a range of 105 yards, the remainder of the spectators fled in confusion, and nothing was left of the pyramid but a large hole in the ground.

As, however, it was of the utmost importance from the point of view of impressing the enemy, that there should be no danger of the real charge acting as a *camouflet* and shaking the pyramid down rather than blowing it up, it was decided to double the charge for the actual operation. A second model pyramid, built rather more slowly and tested with an 18-lb. charge, produced the same result.

Accordingly, the actual charge was settled at 1,600 lb. of gelignite and 250 lb. of guncotton, the latter being a consignment which had come into the country by mistake, and which had for the past three years been causing the maximum of annoyance to all concerned by its habit of going dry and having to be re-wetted.

To deal with the pyramid itself, if the charge were placed 10 feet above ground level, a tunnel about 60 feet long would be required. Naturally, neither the equipment nor training of the Sudanese Field Company had ever envisaged mining, though all the men were trained in handling the explosive for road-making and well-sinking purposes. All equipment, therefore, such as miners' picks, trolleys, an electric lighting set (the accumulator to be charged by the wireless set accompanying the column) and a ventilating plant, contrived from a field forge and some standard delivery hose, had to be made up locally and sent down, together with a mile of copper telegraph wire and some porcelain insulators, to enable the firing party to get well away.

It was fortunate that, although finally the troops moved at only 18 hours' notice, there was ample warning to have things ready to blow up the pyramid when required.

The early stages of the advance from the river base gave some useful opportunities for construction of flying bridges, rafts being made of petrol tins to supplement the collapsible 24-man raft which forms part of the equipment of a sapper platoon in that sort of country, and which was left at the worst crossing. Later, while the ground troops were scouring the country in search of the enemy, the various *khors* dried up, and a M.T. road was then pushed through to a point about 30 miles from the pyramid. The operation of road-making consisted chiefly of clearing the grass and bush and towing an American grader over the cracked cotton soil at the tail of a lorry. The blacksmiths of the platoon were heavily employed on repairs to

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the grader, as the manipulation of the knives on the latter needed considerable practice, and when a 6-wheel Thornycroft lorry made up its mind to go forwards, no protests on the part of the grader, whose knives might have met a rock or a tree stump, were of any avail. The grader proved very successful, but it is worthy of note that a considerable amount of practice is necessary in operating these machines if disaster to the knives is to be avoided.

When finally it was decided that the pyramid should be tackled, the Platoon moved there with an escort of one company (100 men), as it was hoped that the news that the Government was actually working on the pyramid would inspire Mr. Gwek to make an effort to save it. Half of this escort went off at once to guard the only water supply, 15 miles away, whence convoys came in every other day with a supply of 1½ gallons per man per day, no large amount for men working underground with the temperature up to 105°F. daily, and no shade other than their blankets and ground sheets. There was one tree, but that was occupied by the unexpired portion of the water ration, and its guard. There was, therefore, considerable relief all round when it was found that the gallery could be dug without any timber lining, thus halving the time involved.

Naturally enough, no Sudanese soldier had ever heard of a mine before (the subsoil at Headquarters in Omdurman being all rocks, it had not been possible to practise any of the men before starting off), though well-sinking had given them some practice in working in a confined space. Fortunately, they were immensely interested in the forthcoming explosion, and worked with amazing energy. The length of the gallery was 62 feet, and, working continuous shifts, four hours on and eight hours off, this was completed in exactly 62 hours' work. This, in spite of the fact that some enthusiastic miners excavated a gallery big enough to pass a laden pack-mule, while others wandered off in all sorts of queer directions, if not constantly watched. The last shift of seven men at the extreme end of the gallery excavated 72 cubic feet in a four hours' shift, without changing the man working on the face; this in an average temperature of 95°, and on a limited water ration.

The charge chamber was cut at right angles to the end of the gallery, to avoid risk of blowing out the tamping. Six 50-lb. boxes of gelignite were left intact, with only their lids removed, with the idea that they might explode instead of detonating, thus increasing the lifting effect, while the remainder were unpacked, and the sticks stacked in solid, together with the guncotton. Two independent firing circuits were put in, each having 3 detonators in gelignite and 1 in guncotton. In his relief at the completion of this task (the Sudanese treat explosives and detonators with cheerful familiarity), the sapper officer stole the whole of one man's water ration and had a bath in it.

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Work having proceeded well ahead of schedule, the opportunity was taken to tamp the whole gallery to the mouth while waiting for the spectators to arrive.

Finally, on the morning of February 8th, the spectators, consisting of all the troops who could get there, the District Commissioner and 34 Nuer chiefs of varying degree, with their followers, were assembled three-quarters of a mile from the pyramid, the District Commissioner harangued the assembly, explained that the magic of Mr. Gwek was powerless against the magic of the Government, pointed the obvious moral and announced that he had only to lift his hand for their sacred pyramid to dissolve in a cloud of dust. The late enemy were extremely subdued and rather nervous—the sapper officer was also somewhat subdued and extremely nervous. At last, the District Commissioner raised his hand, a concealed sapper trod on the exploder, and a vast cloud of dust where the pyramid had been, caused one man at least to cease feeling nervous and subdued.

Actually, although the pyramid was completely wrecked, there were two rather disappointing features. One was that, presumably due to a strong cross-wind, the explosion was almost inaudible at the firing point; the second, was that the explosion, instead of spreading the pyramid all over the surrounding country, sent it almost straight into the air, hardly anything of any size falling more than 50 yards away. The charge blew upwards and outwards at an angle of about 15 degrees to the horizontal, leaving an irregular crater wall about 15 feet high, which was partially filled up by the falling debris. The probable explanation for the charge failing to act like those in the model pyramids is that, in the course of years, the rains had washed the mud down from the sides of the pyramid, and deposited it round the base, with the result that the bottom 15 feet, instead of having the same slope as the remainder, and as appeared in the ancient photograph, had flattened out to about 25 degrees, and consequently the base at ground level was a great deal thicker than had been allowed for.

Like all natives, the spectators very soon recovered from their fright, and within a very few minutes were swarming over the debris, with shouts of delight, hooting with laughter when anyone asked what they thought of Gwek's magic now. The British members of the party swarmed over the debris, too, hoping to find some of the ivory which was said to have been buried there (one English paper went so far as to describe the pyramid as built of mud and ivory), but beyond a number of decayed and crumbling tusks near the altar, at the foot of the pyramid, there was nothing to be seen, nor were any other curios found.

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IMPACT.

By LIEUT.-COL. L. E. HOPKINS D.S.O., O.B.E., R.E. (*retd.*),

THE coefficient of impact for railway bridges is an empirical allowance to provide for the extra stress or deflection produced in an iron or steel girder by a moving load, compared with the same load when stationary. It has, for many years, been a popular subject for investigation and controversy.

The impact coefficient does not provide for centrifugal forces or longitudinal forces or secondary stresses, which theoretically might be included in the above definition. Such forces can be calculated with reasonable accuracy. It is the vibration of the beam or girder, producing deflections over and above the static deflection, and the relation between the forces which causes the vibration and the effects, which have given rise to such long controversy.

From about 1870 onward, the usual practice was to double the live load stresses, and add them to the dead load stresses, and allow 8 tons per square inch for steel. The Board of Trade rules, down to 1923, merely provided that stresses should not exceed 6½ tons per square inch, without any allowance for impact, but in practice, stresses were calculated by doubling the live load stress.

At the close of last century, the American Bridge Company introduced the Pencoyd formula :

$$I=\frac{300}{300+L}$$

I = percentage to be added for live load ; where L is the loaded length of girder for the maximum stress in the member under consideration.

This formula was very largely used down to 1923, when the British Engineering Standards Association introduced the formula :

$$I=\frac{120}{90+L}$$

where I is the percentage increase for live load stresses, *i.e.*, for 30-span, the stresses were to be doubled, and for 150 feet span the increase was 50 per cent., where the whole girder was carrying a live load.

In 1908, the American Railway Engineers' Association had carried out a large number of tests of girders under moving train loads, and these had confirmed the theories of Professor Turneaure and others, that the added deflection produced by live loads was due to the vibration of the girder. This vibration was not due to the

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rapidity in application of the load, nor to inequalities or imperfections in the track or the locomotives to any great extent. The principal cause of the vibration in the case of railway bridges of 30 feet span and over, was what is commonly known as the hammer blow of the balance weight on the engine driving wheels.

Unfortunately, theory could not be reconciled with the results of tests in practice, and although the Americans recommended the use of a new formula, practically the old Pencoyd formula was not superseded. In India, it was decided to make further investigations before scrapping the Pencoyd formula.

The object of all these investigations was not merely a thirst for academic knowledge. It was desired to reduce the cost of girder work.

For instance, the stresses in the lower boom of a 150 feet span Pratt Truss, may be :

Dead load, 91,700 lb.
Live load, 227,500 lb.

If the live load is doubled, the cross-section of steel required is 30 square inches for a stress of 18,000 lb. per square inch. If the live load is increased by the Canadian formula :

$$I = \frac{L2}{L + D}$$

where L is live load,
,, D is dead load

and 16,000 per square inch permitted, according to Canadian practice, the area required is again about 30 square inches.

If the Pencoyd formula is used the live load must be increased 66 per cent., and the area required for 18,000 per square inch is 26 square inches only. If the new B.E.S.A. formula is used, the impact is 50 per cent., and the new Indian formula, $\frac{65}{45+L}$ reduces the impact allowance to 33 per cent., and the area of the cross-section is reduced to 22 square inches. Approximately, this means a saving of nearly 27 per cent. in the amount of steel for a new girder. In the case of an old girder, the load which can be permitted to cross the bridge can be largely increased, and the life of the girder prolonged, and the cost of renewal postponed.

The importance of the whole subject can, therefore, be easily understood, if economy of management is given proper consideration.

In 1917, the Indian Bridge Committee commenced its new investigations. Large numbers of new tests were carried out, and abstruse mathematical calculations were followed up, but by 1924 the practical conclusion of the Committee was that no reduction of the impact factor was possible, and recommended further investigations and experiments. The view of the Railway Board

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now was that if the experiments already made could not solve the difficulty, it never would be solved, and the Committee was dissolved by Sir Danvers Waghorn, then President.

Meantime, there was a growing conviction among all bridge engineers in India, that higher loads could be permitted over their bridges, and the need for economy in renewals pressed their views to the front.

The new Chief Commissioner, Sir Clement Hindley, was anxious to arrive at some conclusion, and when I joined the Board and promised him results in a few months, he decided to assemble a new committee of practical bridge engineers, to see what could be done.

The solution of the difficulty was really very simple, and had occurred to me one day while crossing the Jumna Bridge, at Delhi.

This is a series of 300-foot girders, carrying the railway on the top, and the roadway on the bottom boom.

Driving across the bridge, I noticed that an *ekka* (native pony cart) which, standing, could cause no deflection, actually when trotting across caused very considerable vibration. In other words, the ratio between the added vibration and the standing deflection must have been enormous.

It immediately occurred to me that impact coefficients obtained when the load on the bridge was small, could not possibly apply to cases where the bridge was fully loaded, and that if one were to run an engine across a bridge with the smallest possible loading, it would produce vibrations which would have no application to the case of the fully-loaded bridge.

This elementary principle could be found in the existing mathematical formulæ, which it had been found difficult to reconcile with the tests results.

In all these formulæ, the added deflection is shown to vary inversely as the static deflection and the total load.

Consequently, the percentage of added deflection arrived at by experiment, with small loads, could not be applied to calculate the effect of impact on a fully-loaded bridge.

Working on this principle, the Committee were able within a year to reconcile the tests with the mathematical theory, and the formula they recommended has now been adopted by the Indian Railway Engineers Conference.

$$I = \frac{65}{45+L} \text{ (For modern designs)}$$

where I is the percentage by which the live load stresses are to be increased,

,, L is the loaded length of the bridge when the member under consideration is fully stressed.

For old-fashioned shallow girders, a lower factor would be sufficient.

In adopting this formula, Indian Engineers are enabled to design

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their bridge work with confidence that they are nearer to the truth than either American or English engineers.

German engineers have already adopted a formula which gives slightly lower results than our new Indian formula.

In short spans, where impact is mainly a question of imperfections of track, bad joints, bad approaches, imperfectly bedded girders, defects which are difficult to avoid in the maintenance of tracks over small girder bridges, the formula gives factors in excess of 100 per cent. It is thought by many that 100 per cent. is sufficient, but there is no doubt that with bad maintenance, much higher factors can be needed. The Committee, however, recommend 100 per cent. as a maximum, relying on the factor of safety to take care of anything worse than that, and influenced by the cost of strengthening the enormous number of small bridges, which might be affected.

Obviously, if the locomotive balance weights are the main cause of impact on railway bridges, the first thing to do was to reduce the cause or get rid of it entirely. I endeavoured to induce the locomotive designers to adopt the four-cylinder engine which would eliminate the need for balancing, or in the case of two-cylinder engines to reduce the weight of the reciprocating parts by the use of high tension steel.

The weight of reciprocating parts is usually about $\frac{1}{180}$ of the weight of the engine, but this can be reduced to $\frac{1}{240}$ by the use of special steel.

I did not meet with much encouragement at the time, but I understand that these views are gaining ground, and likely to be adopted. But, of course, large numbers of older locomotives will remain in use. But the point is, that when heavier locomotives are required, they can be run over existing bridges by designing them with four cylinders or less over-balance, and in this way largely eliminating vibration.

It was necessary, however, to tie the locomotive engineers down to some limit in their methods of balancing locomotives, and the Committee laid down that the ratio for the heaviest loading

$$\frac{Mr}{C} \text{ should not exceed } 830,$$

where M is the weight of balanced portions of the reciprocating parts on one side of the engine in lb.,

„ r=the radius of crank in inches,

„ C=circumference of drivers in feet.

An influential Committee has been working on the whole subject in England for some years, and I understand their report is about to be issued. It will be interesting to see to what extent they agree with the work of the Indian Committee.

Further information on this subject can be obtained in *Technical Paper, No. 247, Railway Board*, published by the Government of India, Central Publication Branch, Calcutta, 1906.

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WELLINGTON COLLEGE FOOTBRIDGE.

By LIEUT. E. H. IEVERS, R.E.

THE erection of a permanent bridge over a railway does not often fall to the lot of a Field Company in peace time, but the 38th Field Company at Aldershot was fortunate enough to secure such a task, during its 1928 Fieldworks Course, in the erection of a steel footbridge over the Southern Railway at Wellington College. It is thought that a description of the work may be of interest, especially to Old Wellingtonians in the Corps, and that mention of how various small problems were tackled may be useful to anyone who has to undertake similar work without previous experience.

In 1926, the Wellington College authorities purchased the large Polo field, on the west side of the railway, in order to provide additional recreation grounds. It was a long way round from the College to the south end of the Polo field, by way of the existing road-bridge at the station, and, consequently, it was proposed to build a footbridge over the line in the position shown on the map. After much delay, a design was approved by the Southern Railway, an order placed with the Furness Shipbuilding Company, and the steelwork delivered.

As the result of a suggestion by an Old Wellingtonian, that the bridge should be put up by the R.E., the task of erection, except for the centre span, was eventually given to the 38th Field Company. The Railway Company insisted on erecting the centre span themselves.

Owing to the fact that the bridge was over a railway, the steelwork was very much heavier than would be expected for a mere footbridge. The roadway, of 4″ concrete slabs, was to be carried on two I-beams, each 20″ × 6½″, and weighing 65 lb. per foot run. These were to be supported on steel trestles—weighing about 1,750 lb. each—bolted down to fairly large concrete bases.

The railway at the site runs in a cutting nearly three times as wide as necessary to accommodate the double line of metals. The bottom of the cutting, on both sides of the railway, was undrained and marshy. The centre span of the bridge had to be 40 feet, and there were four other spans, each of 28′ 9″, making the total length of the bridge 155 feet.

The diary which follows shows the progress of the work. It will be seen that the concreting was done in under four days, that the

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concrete was given a clear fortnight to set before erection began, and that the Field Company's share of the erection was done in four days. The party, shown as forty other ranks, varied from day to day between 35 and 45. It included a proportion of N.C.O.s, and also a cook and assistant, who provided dinners on the site. The men had breakfasts and teas in barracks, and went to the job daily in two 3-ton lorries. Though the party paraded in barracks at 8 a.m., owing to the time spent in transit between Aldershot and Wellington College, and the lunch hour, only about 5½ hours per diem were actually spent at work.

DIARY.

Date.	*Party.*	*Task.*
10th April	2 Officers, 2 College Workmen	Made section of gap with Dumpy Level. Dug test pits.
Wed., 25th April	2 Officers, 2 Sappers	Laid out centre line and taped out foundations ready for excavation.
Thurs., 26th, and Fri., 27th	1 Officer, 40 O.R.s	Drained site, excavated for foundations. Placed shuttering in position, erected store tent. Dug and revetted steps into sides of the cutting.
Mon., 30th April	1 Officer, 40 O.R.s	Laid water supply. Prepared bankers and chutes. Began concreting.
Tues., May 1st, May 3rd (Thurs.) May 4th (Fri.)	1 Officer, 40 O.R.s	3½ days concreting.
May 5th (Sat.), to May 14th	4 Sappers	Went to site daily on bicycles. Struck all shuttering and floated off the tops of concrete bases.
17th (Thurs.), 18th (Fri.)	1 Officer, 40 O.R.s	Laid Decauville across Polo field. Moved two girders up to site. Began preparation of derrick. (Rained both days.)
May 20th (Sun.)		Southern Railway Company erected centre span. Two trestles and two girders, with cross-bracing.
21st (Mon.)	1 Officer, 40 O.R.s	Erected derrick, then one trestle and both girders of first bay. Fixed ballast plate, handrail standards and cross-bracing.
22nd (Tues.)	1 Officer, 40 O.R.s	(Late starting work, owing to lack of transport.) Launched one girder of second bay, and moved the other up ready for launching.
23rd (Wed.)	1 Officer, 40 O.R.s	Launched second girder of second bay. Moved derrick and erected trestle at College side of the bridge.
24th (Thurs.)	1 Officer, 40 O.R.s	Launched all four girders at College side. Fixed ballast plate, handrail standards, etc.
25th (Fri.)	1 Officer, 40 O.R.s	Removed derrick, completed cross-bracing, tidied up site and evacuated. (2 hours' work only.)

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Setting Out.

The four concrete bases for the trestles were designed to be 12 feet long and 4 feet wide, and the first matter to be decided was their depth. Test pits were therefore dug: as a result of which, it was proposed that the foundations should be 2 feet below the lowest ground level. This meant that the bases had to be 4 feet deep altogether, in order that the bridge should have the necessary clearance of 15′ 3″ above the permanent way. It was decided to make the abutments at the top of the banks 4′ 6″ deep, on account of the rather loose sandy nature of the sides of the cutting. Eventually, however, the trestle bases were made 4′ 6″ deep and the abutments 5′ 6″ deep, in order to satisfy the Railway Company.

The centre line was laid out at right angles to the railway by theodolite. A stout peg was driven into the ballast in the middle between the two lines of railway, and a post driven in rear of each abutment. The centre line was marked accurately on each of these by a nail. The theodolite could then be set up over either of the posts for checking the centre line without having to worry about when the next train was due.

The marking-out of the positions of the four trestle bases was straightforward, as they could be measured direct from the centre peg. This was not the case with the abutments, as these were at a higher level and 150 feet apart in the clear. In order to locate them, a distance equal to half this span was measured along the railway from the centre peg. At the end of this the theodolite was set up, and an angle of 45 degrees laid out on each side of the railway. Intersections were thus obtained on the centre line of the bridge, which fixed the positions of the two abutments. A steel tape was used for all horizontal measurements, the same tape being employed throughout.

Two pairs of pickets were driven in on each side of the trestle bases, and slats were nailed across each pair so that the tops of the slats were at the level of the tops of the finished bases. These slats were also used for marking the two lines of holding-down bolts.

Concreting.

Concreting was carried out on both sides of the railway simultaneously—two separate working parties being employed. Ballast and cement were delivered as required, close to each abutment, under College arrangements. Bankers, for mixing the concrete on, were placed at the foot of the cutting on both sides, and the materials run down to them by chutes. A piped water supply was laid on to each banker from a 400-gallon tank, on the top of the cutting on the College side. This tank was filled through fire hose from a hydrant about 400 yards away.

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The proportions of concrete used were one of cement and six of ballast. The latter was naturally graded and of good quality, and no sand was required with it. The total volume of the concrete was 1,300 cubic feet, and it was laid in 18 working hours. Hence, the average rate of laying was 72 cubic feet per hour. As sufficient men were available, namely, about 17 each side, the rate of work was limited almost entirely by the size of the bankers. These were each 18′ × 8′. One-third of each was taken up with the ballast and bags of cement which came down the chute, the middle was used for gauging up the proportions and mixing them dry, and the remainder for wet mixing. As soon as one batch was mixed, it had to be taken

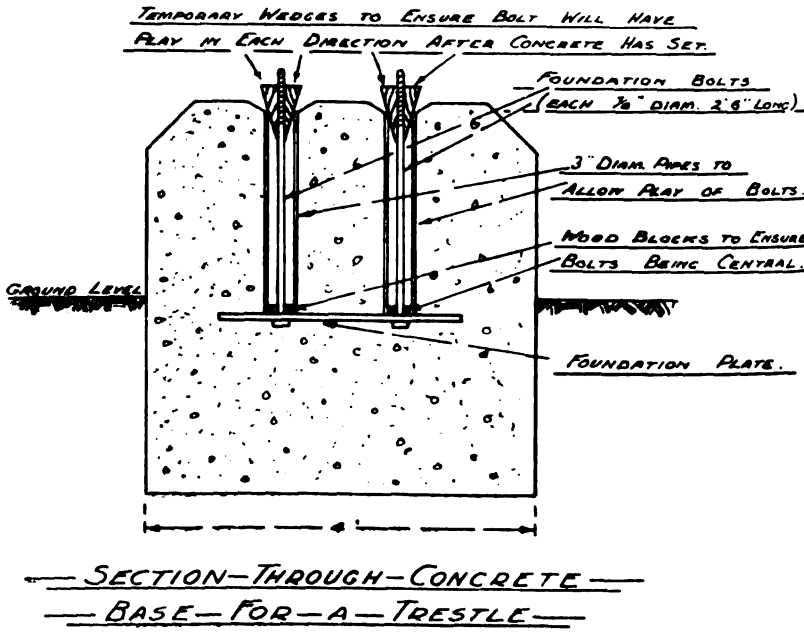
Temporary Wedges to Ensure Bolt will have
Play in Each Direction After Concrete has Set.
Foundation Bolts
(each ⅞" diam. 2'6" long)
3" Diam. Pipes to
Allow Play of Bolts.
Wood Blocks to Ensure
Bolts being Central.
Ground Level
Foundation Plate.
Section Through Concrete
Base for a Trestle

FIG. 1.

away before there was room to mix the next. Thus, half the time the " mixing " men were waiting for the wheelbarrow men to " clear the decks," and the rest of the time the wheelbarrow men were waiting for something to barrow. The rate of concreting could have been nearly doubled if the bankers had been twice as large. There would then have been room on each banker for one batch to be mixed dry, while the next was being gauged up, and for one batch to be mixed wet while the previous one was being barrowed away.

The other source of delay in concreting was the accurate placing of the foundation bolts and plates. There was a pair of bolts and a foundation plate to hold down each foot of each of the four trestles. Owing to their size, it was not practicable to leave holes in the con-

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crete, so that the bolts and plates could be put in position with the rest of the steelwork and grouted in afterwards. It was impossible to fix them absolutely accurately in a mass of wet concrete, and in order to ensure that the feet of the trestles would fit over the bolts, it was essential to provide for a little movement of these during erection. This was arranged by placing lengths of pipe, of 3″ diameter, round the bolts, as shown in Fig. 1. Channels were left on the surface of the concrete to enable the pieces of pipe to be grouted with cement after the trestles were erected.

There were no holding-down bolts in the abutments, but, in the end, handrail standards had to be let into the concrete for a depth of one foot. Slots 15″ × 6″ were left in the concrete for this purpose. The timber casing used for forming slots such as these in concrete should be tapered, well soaked, and finally greased on the outside to facilitate removal. It should not be nailed together, but tied round the outside with string, while the sides are kept apart by distance pieces. The removal of the latter will then allow the casing to collapse inwards when it is required to take it out.

Erection of Steelwork.

The positions in which the steelwork had been dumped are shown dotted on the map. Chiefly with the object of giving the Company some practice in laying Decauville track, it was decided to lay a line across the Polo field, on which the girders for that side of the bridge, and heavy stores brought out from barracks, could be moved up to the site. The girders weighed 65 lb. per foot run, and as it was possible to get men lifting on both sides, they were put on the truck by hand.

Little need be said about the method of erection, as this is illustrated in Figs. 2 to 8, and also in Photos 2 to 6.

When the Railway Company came to erect the centre span, they also brought down the two outer trestles from the station, and dumped them on the site for us. The crane they used had a 40-foot jib, and a safe working load of 20 tons; consequently, their part of the erection was simple, and soon completed.

We began work from the Polo field side and used one 30-foot derrick with its foot placed between the first two trestle bases, at a distance of one-quarter of the span from the centre of the one next the abutment. In this position it was used (*i*) to erect the trestle; (*ii*) to haul out the first two girders, in conjunction with the preventer tackle; (*iii*) to swing the next two girders into position in the second bay.

Each of the first two girders was launched on the centre line of the bridge, and the tail was lifted off the launching roller and moved into position, with a lifting and traversing jack. After the first bay

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Fig 2. ERECTING 30 FOOT DERRICK.

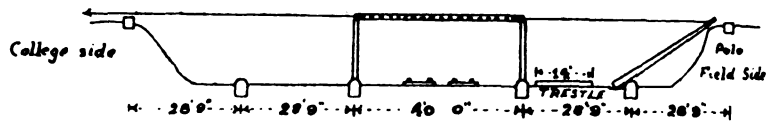


Fig 3. ERECTING TRESTLE

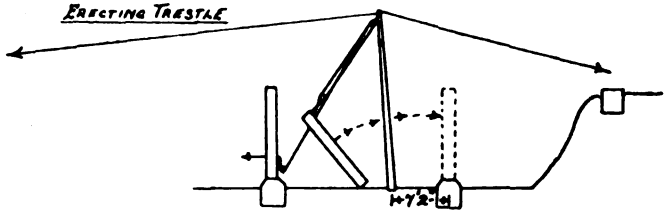


Fig 4. HAULING OUT A GIRDER FOR 1ST BAY.

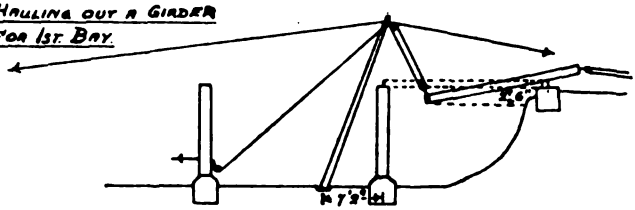
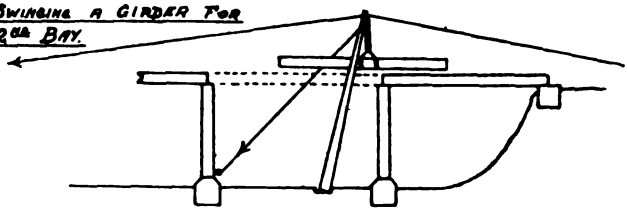


Fig 5. SWINGING A GIRDER FOR 2ND BAY.



HOISTING UP DERRICK BETWEEN GIRDERS.

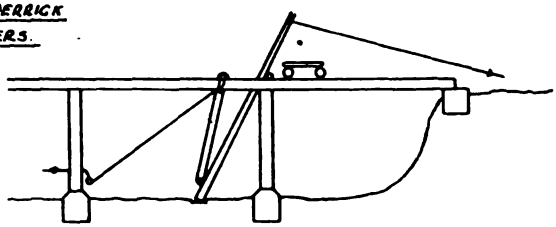


Fig 6.

LAUNCHING DERRICK OFF END OF BRIDGE INTO NEW FOOTING

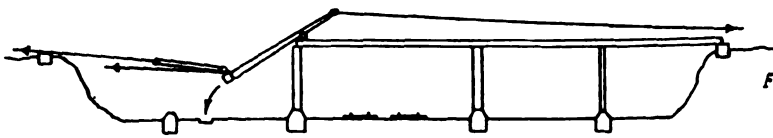


Fig 7.

LOWERING LAST GIRDER INTO POSITION

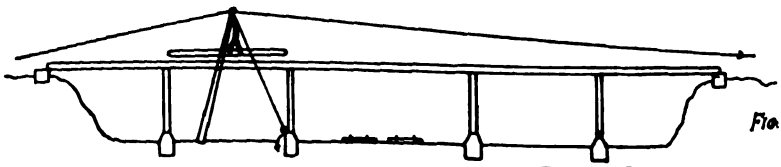


Fig 8.

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was completed with cross-bracing, ballast plate and handrail standards, Decauville track was laid on top. Each girder for the next bay was then run out over the first bay and swung into position.

Before the second girder could be slung, the top block of the lifting tackle had to be unlashed from one side of the derrick and lashed on to the other side, which caused some delay. This was avoided when working on the College side of the bridge by having a S.W.R. strop lashed over the head of the derrick, as seen in Photo 4. This enabled the tackle to be removed from one side of the derrick and hooked on to the other very quickly.

A long chain sling was borrowed from the Stationmaster and used throughout the erection. This was very much more convenient than a S.W.R. one would have been. It could be passed round the head of a trestle or round a girder without the trouble of putting in packing, in order to round off the sharp bends. Had they been available, two separate chain slings would have been ideal, each sling being 6 feet long; since the use of a single long sling with the girders necessitated distance pieces, as seen in Photo 3, to keep the two branches of the sling apart.

After the four girders on the Polo field side of the bridge had been bolted into position, the side guys of the derrick were removed, and it was pulled up between the girders, as shown in Fig. 6. When the erection of the second bay was complete, the Decauville line over the first bay was continued to the end of the bridge. The derrick was then moved across and launched straight into its new footing (Fig. 7).

The erection of the College side of the bridge was similar to the other, but as a result of the previous experience, there were no delays. All four girders were put into position on the same day; and the derrick and all stores were removed, and the whole site tidied up in a couple of hours on the next morning. The painting of the bridge, and the laying of the roadway of concrete slabs were done by the College workmen subsequently.

While the erection was in progress, spare sappers were employed in banking up earth round and between the concrete bases and digging protective drains. This has resulted in the ground round the foundations becoming dry and firm.

Owing to the marshy ground, it was essential to have a bearing plate under the foot of the derrick, and a strong box-footing was made. This was held in place by pickets driven in round it. To enable the men on the fall to pull along the bank beside the line, which was the only dry place, the leading block was not lashed to the foot of the derrick as usual, but fastened to the base of the trestle already erected next to the railway. This also enabled footropes on the derrick to be dispensed with, as the pickets round the footing were quite sufficient to take the small horizontal stress. When

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moving the derrick, the pickets round the footing were pulled straight out by means of the main lifting tackle.

In the design of the steelwork, no allowance was made for expansion and the girders butted tightly together where they met over the trestles. It was thought advisable to leave room for expansion at one end of the bridge at least, and accordingly clearance was left in the slots for the handrail standards at the College end. These spaces were unfortunately filled in by the College workmen when laying the roadway and concrete steps; and although the expansion for a 50 degrees (Fahr.) rise of temperature works out at only about half an inch, it was nevertheless sufficient to force the steps that amount back from the end roadway slab of the bridge.

CONCLUSION.

For various reasons, the erection of this bridge provided an excellent task for a Field Company. Firstly, all materials required were supplied at the site by the College Clerk of Works. Consequently, no days allotted for training were spent in collecting materials, transporting them to the site, and dismantling and returning them to store afterwards, as is usual in barracks. Secondly, the work afforded the opportunity of employing an exceptionally large proportion of sappers at their trades. Carpenters were wanted for making the shuttering, masons and bricklayers were employed on the concreting, plumbers laid on the water supply, and the fitters did the bolting together of the steelwork. The blacksmiths also had their turn when a special launching roller, suitable for the girders, was required. Thirdly, it was a novelty for many of the Company to see a derrick put to real practical use, and all gained some experience in the use of tackles, anchorages, strops, slings and so on.

The chief merit of the work, however, apart from the practical training afforded, was the satisfaction which all ranks could feel in knowing that they were building something which was to last, instead of something—as normally in a fieldworks course—to be dismantled the following day. The result was that a really live interest was shown by all ranks.

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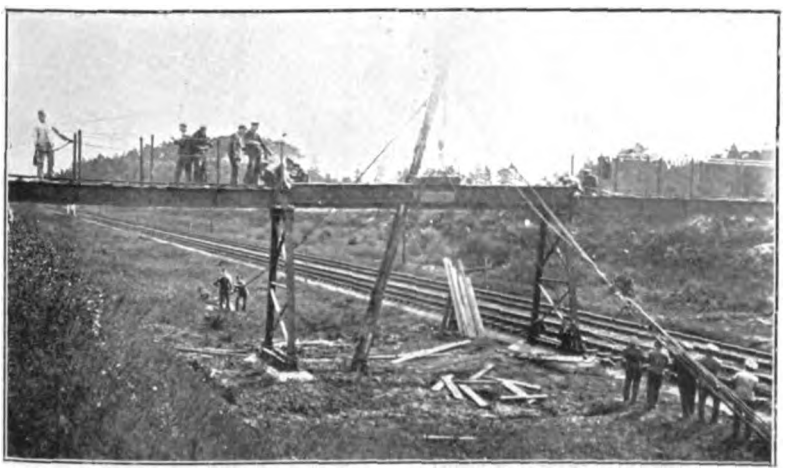
WELLINGTON COLLEGE FOOTBRIDGE.

1.—Ready for erection of steel work.

[Men in this photo belong to Southern Railway Co., and are replacing overhead telephone wires by cables.]

2.—Putting first trestle in position.



3.—Lowering a girder into position.

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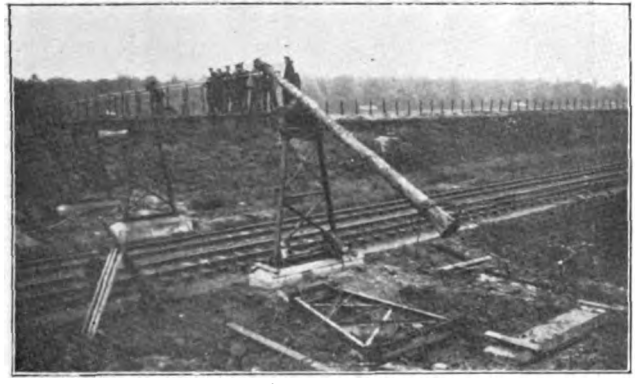
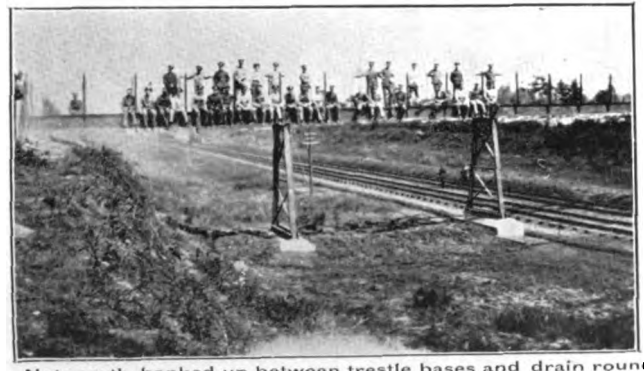
4.—Showing strop over head of derrick.



5.—Launching derrick into new footing.

6. -Removing derrick.



7.—Note earth banked up between trestle bases and drain round.

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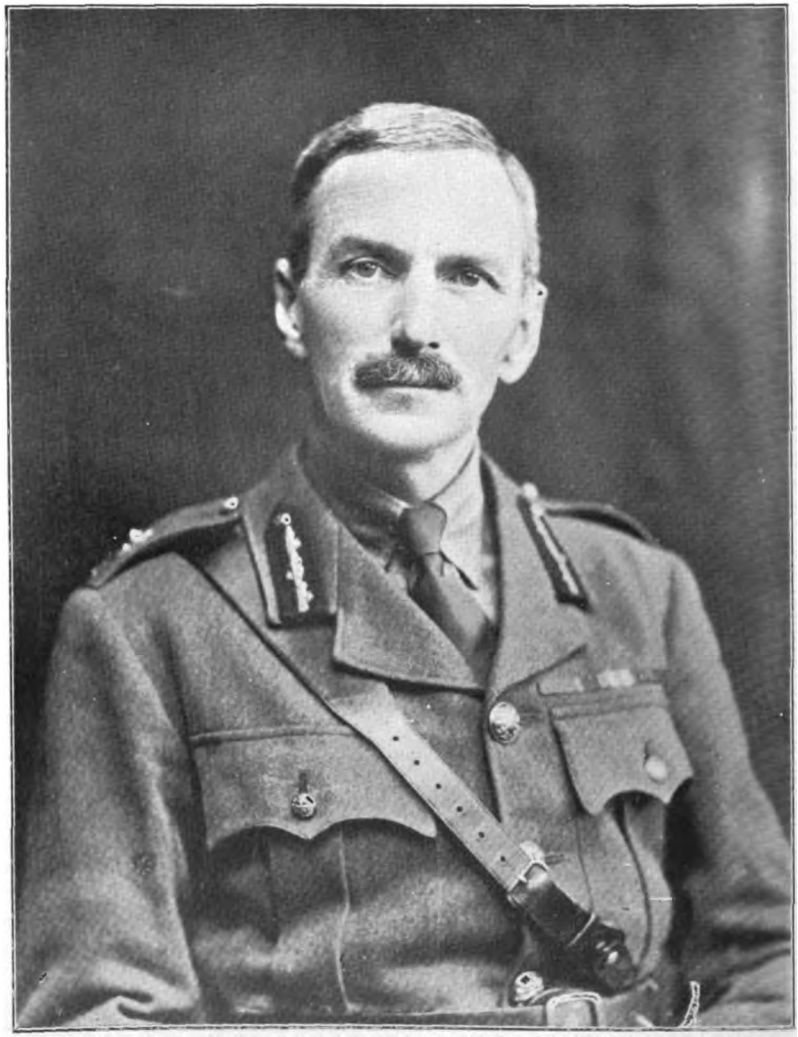

Major-General Sir Gerard Moore Heath, K.C.M.G., C.B., D.S.O.

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MEMOIR.

MAJOR-GENERAL SIR GERARD MOORE HEATH, K.C.M.G., C.B., D.S.O.

MAJOR-GENERAL SIR GERARD HEATH died at Mentone on January 9th, 1929. His health had broken down immediately after the end of the War, and had always been a matter of anxiety, although with his usual courage he still " carried on " to the best of his physical strength. It was, in fact, as a result of trying that strength too far that he was ordered immediately to the South of France, and he arrived at Mentone on Christmas Eve, 1928.

Sir Gerard was the youngest son of the late Admiral Sir Leopold Heath, K.C.B., *J.P.*, of Anstie Grange, Holmwood, and a brother of Major-General F. C. Heath-Caldwell, C.B., late R.E., who, among other appointments, held those of A.A.G. R.E., and Inspector of R.E. He was born at Anstie Grange on June 7th, 1863. He obtained his Commission in the Royal Engineers on February 22nd, 1882, being by some months the youngest of his batch.

On leaving the S.M.E. in June, 1884, he joined the 1st Divn. Telegraph Battalion at Aldershot, and at the end of January, 1885, went with a detachment of it on the Bechuanaland Expedition under Major-General Sir Charles Warren.

After nearly a year's absence he rejoined the Telegraphs at Aldershot and remained with them till he went to India in November, 1887, serving with the Bengal Sappers and Miners at Roorkee.

He joined the Staff College, Camberley, in January, 1891, and remained there for the prescribed two years. After a short spell in the I.G.F.'s office and at Aldershot, he returned to India in the autumn of 1893, rejoining the Bengal Sappers and Miners. He served with them in command of the Pontoon Section with the Chitral Relief Force, 1895, being employed in bridging the Swat River and other smaller rivers, and remained in charge of bridges and the control of the traffic over them. In connection with this, General Sir Bindon Blood, who was Chief Staff Officer in this campaign, writes :—

" The construction and maintenance of the bridge over the Swat in 1895 was one of the best bridging performances ever carried out by the R.E. on active service. The Swat River is a torrent when it is in flood in the summer, and, if I remember aright, the current in 1895 went up to nine miles per hour, while the bed consisted of rock with loose boulders of all sorts and sizes, so that the anchorage of the pontoons used (doubled end-to-end) was an aerial wire rope. My recollection is that the bridge was maintained for some months,

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until it was replaced by a more permanent structure, in such a manner that our communications, which depended upon it, were never seriously interrupted. Our Corps somehow never made enough of the bridging in the Chitral Expedition, especially the Swat Bridge and the two over the Panj-Kora."

Captain Heath was mentioned in dispatches with others as "having brought the greatest credit on the Corps to which they belong."

He came home in June, 1896, and commanded the Balloon Section at Aldershot till September, 1899, when he proceeded with it to South Africa.

An officer who was then at Aldershot, but did not come closely in contact with him, writes :—

"I always looked up to him as a real gentleman. . . . He had a fairly tough time commanding the Balloon Section, as it was the Cinderella of the Troops and Companies, and the Powers-that-were had a down on it, but his tact and good temper always turned away wrath."

Being ordered, at the outbreak of the South African War, to join Sir George White's Command at Ladysmith, he was present with the balloon at the battle of Lombard's Kop, after which he was shut up in Ladysmith during its siege by the Boers. For his services he was mentioned in Sir G. White's dispatches.

After the Relief of Ladysmith in February, 1900, Major Heath, having no further use for the balloons, obtained permission to convert the Section into a troop of mounted Sappers, for work with Lord Dundonald's mounted Brigade under Sir Redvers Buller.

Advancing with that force through Natal and the Transvaal, he was present at the action of Laing's Nek, and round Belfast and at many minor skirmishes, being mentioned in dispatches by Sir R. Buller and being awarded the Distinguished Service Order.

At the close of 1900, he joined General Alderson's Mounted Infantry and, in 1901, became Intelligence Officer to General Gilbert Hamilton's Cavalry Brigade, being subsequently appointed D.A.A.G. to that Column, an appointment which he held till near the end of the war in June, 1902.

As Intelligence Officer he formed a small troop of Scouts, some from his R.E., and some from cavalry, and "these would do anything for him or go anywhere with him." He did some very enterprising work in marking down Boer laagers, etc. In those days of guerrilla warfare, when Briton hunted Boer and Boer hunted Briton over the deceptive openness of the rolling veldt, or in the intricate death traps of the broken hills, it was upon the skill and courage of such scouts that the success or otherwise of mobile columns chiefly depended.

In August of the same year, he was promoted a Brevet Lieut.-Colonel for his services, and received the Queen's Medal with five clasps and the King's with two.

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In June, 1902, he was appointed Instructor of Field Fortification at the S.M.E., Chatham, a post which he retained till 1906.

After a short period as C.R.E., London District, he was ordered to India to command the (then) P.W.O. Sappers and Miners at Roorkee. An officer who served with him then writes :—" He particularly set out to apply the lessons of the Russo-Japanese War to the practical training in Field Engineering, and I am certain that the ability with which the Indian Sappers and Miners were able to deal with the conditions in France, were very largely due to his foresight and appreciation of what Sappers would be called on to do. As one under whom to serve, it would be hard to find a better. A strong disciplinarian, yet sympathetic and always ready to discuss and help, he had the attributes of getting the very best out of those under him."

In 1910, he was appointed General Staff Officer to the Burma Division ; early in 1912, he was appointed Brigadier-General of the General Staff in South Africa, under General Sir Reginald Hart, V.C., K.C.B., K.C.V.O.

There are several tributes to his service during this period. As, however, the severest ordeal of judgment to which the character of a senior officer can be subjected is perhaps that of a body of subalterns, it is felt that no more fitting tribute to the memory of Sir Gerard Heath at this period of his career can be given than quoting verbatim from a letter as follows :—

" I met him again in South Africa, where he was B.-G., G.S., from about 1912–1914. It was then that I got to know him well. I was Signal Officer to the Command, and, as such, dealt direct with him in many ways, went with him on Staff exercises, etc. Professionally, he gained our respect and admiration to the highest degree. He was always so clear, concise, and to the point in his instructions and criticisms. He gave us all an example of the very best type of Staff Officer.

" What I remember best was that he never lost the spirit of youth. The result was that it was always a pleasure for us subalterns to be with him. If we had guest nights he would come and preside, and as all the dining members were subalterns, you can imagine how we appreciated this. He was so keen on the Corps, and we were very proud of him. He played golf with us, and often rode nine miles from his house up to the Cantonments to practise tent-pegging with us. He would then breakfast with us and ride back seven miles to his office. It was always obvious that he had been, and was then, a first-class horseman.

" I am afraid I cannot help you more than this ; but what I am trying to describe is that, though a senior and very successful officer, he gained the real affection and respect of juniors in a way that few men can or do."

On the outbreak of the Great War, he was on leave from South

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Africa, and was appointed an Inspector of Recruiting in England in connection with the raising of Kitchener's Armies, and subsequently Inspector of Royal Engineers.

In May, 1915, he went to France as Chief Engineer of the II Corps, under Sir Charles Ferguson. This Corps was then strictly on the defensive; trench warfare prevailed, and his duties were almost entirely devoted to supervising the construction of lines of defence and their maintenance. His beat extended at one time from Armentières to Ypres.

In November, 1915, he was appointed Chief Engineer of the 1st Army, then under Sir Douglas Haig, afterwards under Sir Charles Munro, and finally under Sir Henry Horne.

His duties were mainly "defence," upkeep of roads, water supply, etc., over an area extending from Arras to Armentières and for an Army of about 300,000 men.

At the end of 1916, preparations were begun for an "offensive," the task of the 1st Army being the capture of the Vimy Ridge.

This involved new roads, gun positions, infantry positions, the laying of forty miles of pipe line for the supply of water for 30,000 horses, etc.

The attack, in conjunction with the 3rd Army on the right, took place on April 9th, 1917, and was entirely successful.

Concerning that period, a General Staff Officer, then and now in a high position, writes:—

"During these months from April to October, which, as you well remember, were months of strenuous attack at Vimy and round Lens and Arras, we were, I think, as happy a family as could be found at any Headquarters on the Western Front, and a very good deal of this was due to the quiet, pleasant and unselfish manner of Gerry Heath." He then speaks of his services for the offensive, and describes how he was wounded, and gives as his personal opinion that Heath never fully recovered from the wound, though at the time it appeared a lightish one.

In October, 1917, he was appointed Engineer-in-Chief at General Headquarters, and as such was Advisor to the Commander-in-Chief, Sir Douglas Haig, on matters of engineering, and he remained in that appointment till the end of the War.

There are many tributes to the memory of Gerard Heath when he held this appointment, but it is thought that the following words of a senior R.E. officer are representative of the opinions of others, and give a correct impression:—

"My general memory of him is of one of the most charming and unselfish personalities I have met. I do not remember a single disagreement, or disappointment with one of his decisions.

"He was all out to help, never spared himself mentally or physically; gallant, and with a very keen appreciation of any work done

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for him or gallantry in others; human and cheerful and humorous; friendly and generous with all the world, and as straight as a die in all his dealings—I doubt whether he ever had an enemy.

* * * * *

"He had wide experience of administrative work, and kept in personal touch with all under him, as well as the other branches of the Army."

This personal touch with those under him appears to have been appreciated especially by the Tunnelling Companies, who in turn looked on him as their special friend, both when he was in 1st Army and at G.H.Q.

The following points noted by one who served in close contact at this time must also be quoted:—

1. His wonderful energy and the example he set of maintaining the personal touch by constantly visiting Formation Headquarters, to find out where the shoe was pinching and where he could help.
2. The delightful and hospitable atmosphere of his E.-in-C.'s Mess was due very largely to his own charming character.
3. His straightness of mind and unwillingness to think or believe evil of anyone; his loyalty to his staff with the inevitable response and affection from them.
4. He visited French and American G.H.Q.'s to keep in touch with his opposite members, and the Q.M.G. branches at those two Headquarters.
5. Though his nature inclined his thoughts to the front line, he kept intimately in touch with the Director of Works on the L. of C., and was *au fait* with the larger undertakings and Engineer Store Depots at the Base Ports and on the L. of C. generally.
6. At the outset of the German successes in March, 1918, the Commander-in-Chief sent for General Heath, gave him a map of the British Zone with a wavy blue line across it, and told him to construct a "Hindenberg" Line of Defences approximately on the blue line, and no personnel of any sort was to be drawn from Army Areas for this line.

   Under General Heath's instructions, an organization was created from most miscellaneous sources and a defensive system achieved, the trenches alone totalling five thousand miles."

The writer feels that he must refrain from quoting further from expressions of appreciation of Gerard Heath's personality or services, but there is one point that he must touch on—one that he always felt himself, and one that a General Staff Officer, at one time under him, has emphasized, and that is that, although he never showed it by word or deed, his real desire, and his real *rôle* by instinct and training,

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was to be in executive command in the Field, and it was for this that he was eminently fitted.

The latter added, " He had a remarkable tactical flair, and his criticisms on manœuvres, etc., were always extraordinarily good, terse, and to the point. But, above all, he had that invaluable quality in a Commander, the gift of gaining the affection and loyalty of all who served under him, and indeed the reason is not far to seek, for he himself loved his fellowman, and one knew instinctively that he would never let you down."

As Engineer-in-Chief of the British Army in France from 1917 to the close of hostilities, he was one of the Generals who accompanied Sir Douglas Haig to receive the thanks of H.M. the King at Buckingham Palace on the successful conclusion of the War.

Honours in the Great War :—C.B., American Distinguished Service Medal, K.C.M.G., Order of St. Stanislaus—1st Class, Croix de Guerre (*avec palmes*). Promoted Major-General for distinguished service in the Field. Mentioned in dispatches six times.

Sir Gerard Heath retired from the Army, December 4th, 1919. He married in 1893, Mary, daughter of Philip Egerton, Esq., I.C.S., of Gresford, North Wales, and had one daughter, now the wife of Captain L. R. Hall, M.C., Royal Corps of Signals, and a son, Gerard William Egerton, born in 1897, now Captain, R.H.A., in Egypt. His son received an immediate award of the Military Cross, and was later severely wounded in the leg, but has been prominent since in show jumping and in steeplechases. He was till recently commanding the Riding Establishment at Woolwich.

After retirement Gerard Heath joined the Building Research Board, under the Department of Scientific and Industrial Research, to which he gave his services gratuitously.

He succeeded Lord Salisbury as Chairman, and devoted much time and energy to the furthering of its objects. The following is an extract from a message of condolence from the Board :—

" They felt that the present position of the Building Research Station in itself constituted a lasting memorial to the great work Sir Gerard Heath had done during the six years he was Chairman of the Board."

He also became a director of Chislet Colliery, Kent, and an extract from *The Colliery Guardian* may well be repeated :—" He was ready and willing to give his powerful support to any in trouble or difficulty, and many are the tales that could be told of his own unselfishness and of the way he helped forward younger men. All this could only spring from real goodness and kindness of heart, and he was in every sense of the word a great and good man. His life and work will ever remain a precious and fragrant memory to those who were privileged to work with or under him."

There can be no more fitting words with which to close this memoir.

A.L.S.

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BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

AN EXPERIMENT WITH TIME.

By J. W. DUNNE.

Second Edition. (Black, 10s. 6d.).

(By J. C. Squire.)

(Reprinted by permission from *The Observer*.)

The first edition of this extraordinary book was reviewed in these columns over a year ago by Mr. Kenneth Richmond. It was also noticed in many other places, mostly with an admiration that approached stupefaction. The professed scientists and philosophers were, perhaps, more cautious than the others; but Professor Eddington was not the only one of those to take Mr. Dunne seriously. Yet even now neither the learned world nor the general public has faced the book as it should be faced. Whatever may happen to Mr. Dunne's theories, his facts constitute a tremendous challenge: if they are confirmed, the book is a landmark in human history. Its origin is as curious as its nature. Mr. Dunne, who has a brilliant expository gift, was once famous as the designer and builder of the first British military aeroplane, saw service in two wars, and has hitherto published only one book—which was about fly-fishing. This book should get him the best rise he ever saw.

The work, which is short and mostly comprehensible by the layman, contains the results of certain experiments, and the outline of a theory devised to fit the facts. Mr. Dunne states that for many years he has been recording his dreams immediately after waking, and that various friends have recorded theirs for his benefit. That past incidents, variously grouped and transmuted, appear in our dreams goes without saying. Mr. Dunne's central allegation is that these are, at any rate, sometimes blended with incidents from the future. There is no question here, he says, of coincidence; and none of that self-deception which frequently makes one think that one dreamed something in advance when one probably did not. It is a question of quite peculiar phenomena noted down after dream without knowledge of their significance, and found, after the lapse of days or even years, to have been foreshadowings of "later" events. It is one thing to dream that one's dearest friend is dead, and then to find that he dies: one's fears and affections breed that sort of dream frequently, and one may be sub-consciously influenced by knowledge of his state of health. It is quite another event to dream that one is being chased by an angry horse, to note down the dream (with its surrounding complex), and then to go out and to encounter this very unusual experience. Mr. Dunne tabulates a number of such events, and concludes that the fabric of dream is an interweaving of past and future.

It would be enough for most men to accumulate enough facts to demonstrate that. Not so with Mr. Dunne. Without taking a breath, he proceeds to formulate a new theory of the most remarkable kind. The

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" observer " of the humdrum daily world is replaced, in sleep, by an observer who moves along the Fourth Dimension, Time. Here we come to the crux. Mr. Dunne, in a somewhat hasty preliminary argument, has established a consciousness which is aware of " the first observer," and is superior to the three-dimensional world. The moment that movement in the fourth dimension is granted to be normal, consciousness moves into a fifth dimension. The deduction is an infinity of dimensions and an infinity of observers—a series with one at the mundane end (who has nobody on the hither side to keep him warm and for whom death is postulated) and an " Ultimate Observer " at Infinity who is conscious of all the dimensions. This last conception may be thought the last straw. This whole business of " Serialism " (as Mr. Dunne calls it) makes the lay mind reel : one begins to sigh for a right little, tight little, Four-Dimensional World ! Einstein may have chastised us with whips, but Mr. Dunne chastises us with scorpions. We cannot but hope that, if Mr. Dunne has followers, the earliest of them may find some plausible means of eliminating the vast superstructure of dimensions which he projects in order to account for the initial relations which he discusses. Happily, it is not necessary for the layman to bother his head about " Serialism," or even to go and ask the nearest mathematician what he thinks of an Observer at Infinity. Nor, perhaps, is it as yet imperative for the scientific person to concern himself overmuch with the theory until there has been further investigation of the facts that it is meant to fit. At this stage the facts are the important things. Are they established ? Can they be supplemented ?

At present they are altogether too few. One horse may have chased one man after one dream. We want to know that six horses have chased six men after six dreams. One does not throw doubt upon the good faith of Mr. Dunne and his friends when one says that their stories are not sufficient to convince one, though they certainly impress one. We must have not merely the evidence of Mr. Dunne, and his friends Major X. and Miss Y., but that of large numbers of people of repute and of the most sceptical turn of mind. If all is as Mr. Dunne says it is, there should be no difficulty about this, provided that the physicists and the psychologists have the curiosity to explore this momentous possibility. The written word remains : it is only a matter of getting enough records of dreams and enough evidence of their fulfilment : it is almost laboratory work. A very little organization and we should be able to say definitely whether Mr. Dunne's basic proposition is proven or whether it is not proven to the point of being virtually negligible.

Should it be proven, what a world we are being launched into. Once grant that dreams do actually draw upon the future, and there is a whole new fourth-dimensional branch of scientific activity. In what proportions do the various elements in dreams mingle ? Can constants be found with due allowances for this, that, and the other influencing circumstances ? Does the element of divination in an individual's dreams bear any determinable relation to his particular mental or physical constitution ? Does it vary at all according to age, race, or state of civilization ? If such variations are found can the faculty for prophecy during sleep be fostered ? Are the researches of the psycho-analysts in the

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transmutations and groupings of dreams to be superseded by others far more momentous, which will be concerned with the minglings of past and future images, the affinities of memory and prediction, or, rather, of the observations of past and future made by this voracious Time-Traveller? Will it be possible ever to recognize, in a dream as yet unfulfilled, the stigmata of the "future" event as distinguished from those of the "past" event? And, for that possibility must certainly be confronted, may it not be possible so to surrender one's three-dimensional self, which is so dependent upon the outer impacts of this sensual world, as to lapse deliberately into day-dream, releasing our consciousness for journeys into the future? Or—for that matter—into the past, and even a remoter past than the past of our physical selves. I cannot quite conceive (though it may not be beyond the powers of scientific people to formulate) a parallelism which would preclude our travelling in the Fourth Dimension beyond some point analogous to that of our birth into a three-dimensional world.

However, the Future is enough to start with. If Mr. Dunne is correct—and his abilities and qualifications are quite enough to entitle him to a hearing—we shall be compelled to admit that we all habitually move in a fourth dimension, certainly in sleep, and very possibly, on occasion, when we are not asleep. Granted that, and granted a positive answer to all those questions which I have just posed, we come to a point at which an almost inconceivable abyss of speculation has to be looked into. Once given the ability to isolate the prophetic elements in dream, with certainty or even with reasonable probability, we shall be bound to consider whether or not the foreseen future can be avoided? If we look at the matter in one aspect—thinking of Time as a form of Space with all existing objects stuck in it as prolonged lines with definite shapes, graphs as it were—we are compelled to say "No." Yet there is that obstinate reason in us which obliges us to say, "Yes: I cannot very well fall out of an aeroplane if I blankly refuse to go up in one." This is put crudely, but the problem is evident: we must be given a somewhat strong side-light upon Determinism and Free-Will! And if the dimensional dice are not strongly loaded in favour of the former, what sort of Dimension is this? The old murmur reaches my ears: "A thing cannot both exist and not exist." To that, amid the storms of this changing world, which is curving its straight lines, joining its parallels, and abolishing its matter, I have been clinging with some desperation. I fear that it may have to go into limbo, where the ghost of Aristotle moans to the ghost of Sir Isaac Newton.

Let us keep cheerful: as cheerful as Mr. Dunne, whose book contains more high spirits than I have ever seen in a book with diagrams "so many, and so many, and so free." It is more amusing to see the frontiers of knowledge being extended than to see them fixed. I feel a little doubtful about my own dreams. It was bad enough to think that they were crowded with wish-fulfilments and the reflections of my more disreputable desires: that even one per cent. of them anticipate my personal future is almost too much to contemplate. Yet

> things are what they are; their consequences will be what they will be; why, then, should we deceive ourselves?

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This new thing is better than some new things. Nobody has yet, I think, suggested that the discovery of the fourth dimension will blow our "home-planet" into pieces. As to the possibility that, forewarned, we might begin messing up each other's futures, mankind has been doing very little else since the world began.

Mr. Dunne's "Ultimate Observer," I may add, seems to me to dwell on the confines of Theology. That is another reason why his book is fascinating.

THE EMPIRE AND THE ARMY.
(Cassell, 10s. 6d.)

HISTORICAL AND MILITARY ESSAYS.
(Macmillan & Co., 10s. 6d.)

By the Hon. Sir JOHN FORTESCUE, LL.D., D.LITT.

It is not often that one has the pleasure of welcoming at the same time two books from the pen of the historian of the British Army. Of these two, that which will appeal most to military readers is the first-named, for it has been written expressly for soldiers. It is intended to be a text book, which has long been needed by those who have to teach candidates for the higher certificates of education. It is in part a short history of the British Army, and it can perhaps be criticized for its very brevity. But it is easy to imagine how enormous were the difficulties which faced the writer. The subject is so wide that the inclusion of detail might have obscured the important features of the story which now stand out so clearly. The very fact that the reader is constantly led to demand more detail will provide an incentive to the deeper study of army and regimental history. But this book is more than a history of the army: it is a story in which the author has traced the growth, side by side, of the Empire and of the Army, showing clearly how the two have been interdependent: how it was the necessity for security in some colony or dependency which led to the raising of new regiments, some to be disbanded as soon as the danger was overcome, a few to remain till the present day.

The book will therefore appeal to a wider public than that for which it was written. As Field Marshal Sir George Milne says in the foreword, "it should find an honoured place on every boy's bookshelf," and should be read, not only by those who aspire to certificates, but "by every officer, non-commissioned officer and man."

The second book contains a collection of essays, most of which have previously appeared in periodical publications. The greater number deal with the character of King George III. as it is revealed in his private correspondence, which was discovered in 1912, and has since been edited and published by the author of these essays. Their aim is to re-establish the good name of the King, and to show that the current estimate of his worth has been wrongly biased by the "vindictive hostility of Whig writers." The part more interesting to military readers is that which contains the letters from the Duke of York to the King giving his experiences in the Flanders campaigns of 1793–94.

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The remaining articles in the volume are mostly in a lighter vein. There is an interesting account of the origin and duties of the Lords Lieutenants of the counties, which concludes with a warm tribute to the services rendered by them during the period of the Great War. The last essay is an account of two conversations between Napoleon and Lord Ebrington, Sir John Fortescue's grandfather, at Elba in 1814. These were first published in a pamphlet in 1823, and are now republished from the original manuscript. Much of it is in French, " in as nearly as I could recollect them the very words used by Napoleon," and is of considerable interest.

N.W.N.-C.

THE PRACTICAL ELECTRICIAN'S POCKET BOOK, 1929.

(Published by Odham's Press, Limited, 2s. 6d.)

Thirty-one editions of this Pocket Book have been called for since its first appearance—reliable evidence that it appeals to a large number of readers. Although a good many of the articles of previous years have been retained, the edition is a new one in that thorough revision has taken place, many articles being removed to make room for new ones, contributed by authors well known in the profession.

Engineering year books range from massive tomes, published at a guinea or more, to pocket books in size as well as in name, costing two or three shillings. The compiler of one of these latter is, of course, severely limited in space, and any reviewer has an easy task in criticizing his choice of subject matter.

It would appear that one of two objects should be aimed at :—

(1) The collection of formulæ, tables, and facts which an experienced engineer cannot keep in his head and which he requires in his work.

(2) A collection of short informative articles on all branches of the subject matter of the pocket book.

It is to the second class that the book under review belongs. The information contained is of necessity descriptive rather than precise, and on most subjects is of little use to anyone seeking help for any particular job. As an instance, there are two and a half pages, and small ones at that, on alternating currents—not enough for a novice and unnecessary to anyone with an elementary knowledge of the subject.

Turning to the individual sections, the preface rightly lays stress on the detailed and complete index provided at the beginning of the book—a reference book with a faulty index being worse than a plan unprovided with a scale. Following the index comes a calendar and 14 pages of elementary facts, definitions of units, etc., the next six brief pages on D.C. Generators and Motors, and the two on A.C. theory already referred to, are followed by twenty on boilers, steam and oil engines—this valuable space could better have been devoted to purely electrical matter. The remarks on boilers are admirable, but the turbine section of half a page is entirely useless. The cold-starting type of engine should be referred to in the oil engine section.

Primary and secondary batteries are well discussed, though the range of specific gravity of electrolyte in the latter, from full charge to full discharge, is given as 25 to 30 points ; the usual range is double this.

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Parts of page 70 are too reminiscent of advertisement matter to be in place in a pocket book. To quote :—

"A new type of accumulator . . . is manufactured by the Young Accumulator Co., Ltd., London. . . . In the ordinary lead battery . . . during discharge, the different oxides formed by electrolytic action are transformed into lead sulphates." (Quite true ; this is the main action, and if it did not take place the cell would not function.)

"The special process developed by this company is such that the necessary chemical reactions are greatly strengthened. In this way the formation of sulphate is obviated and greater capacity is obtained from the plates." Apart from the fact that stronger chemical reactions would presumably *increase* the formation of sulphate, the capacity of a cell in which this formation did not occur must of necessity be zero.

When writing on accumulators, it is essential to keep in mind the difference between the normal formation of lead sulphate on which the action of the cell depends, and the abnormal injurious sulphation, and this distinction is not made clear to the reader.

Switchgear, transmission and distribution are ably dealt with, tables of pole sizes, depths to be buried, and conductors being given. Static transformers have as good treatment as space permits, though rotary convertors (spelt wrongly "converters") are dismissed in one and a half pages, while motor convertors and mercury arc rectifiers escape mention. This last is an important omission which ought to be corrected in the 1930 edition. In view of the fact that no transverter is in commercial operation, the page devoted to it might be better filled.

Wiring and lighting account for eighty-seven pages, and are well done. It is a pity the tables of lamps on pages 185 and 203 were out of date before the book was issued, as the 1929 edition of B.S.S. 161 has altered the standard sizes to 15, 25, 40 and 60 watt.

The elaborate tables of depreciation factor are unnecessarily precise in view of the inaccuracy of photometric methods.

The section on wireless includes a short glossary of terms—kilo hertz might be given with advantage in view of its growing use. Sections follow on electric cooking, lifts and cranes, electricity in farming, traction, railway signalling, measuring instruments– the British Standard requirements as regards accuracy should be given here– electro-chemistry, welding, armature construction and repair, and insulation.

The table of the particulars of supply in a large number of towns in Great Britain is a valuable feature.

To sum up, the book is an admirable encyclopædia, but like all encyclopædias is apt to be unsatisfying to an engineer seeking for details. References are given at the end of each section to appropriate text-books.

K.H.T.

TEXT-BOOK OF ORDNANCE AND GUNNERY.

By Lt.-Col. EARL MCFARLAND, Professor of Ordnance and Gunnery, U.S. Military Academy.

(Chapman & Hall, 32s. 6d.)

The first impression obtained by the reader on picking up this book is that in doing so he has only himself to blame.

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For this is a text-book avowedly compiled for the benefit of students at the United States Military Academy, and those who of their own free will wrestle with its contents must be akin to the monks of old, who would heartily flagellate themselves for the good of their souls.

Yet it is quite possible that readers of the *R.E. Journal* may have the curiosity to investigate the trade of the gunner, and further the result of such investigations may perchance result in profit—are we not deeply indebted for research in Ballistics to a clergyman of the Church of England?

Besides, nothing is sacred to a Sapper.

And I can assure the curious that this is a sound book; without going too deeply into details it presents a comprehensive view of the whole field of Ordnance, put forward in simple form and amply illustrated by admirable diagrams. In fact, it clearly justifies the claim of the author that he has attempted therein to "assemble in one book the more permanent and fundamental theories of ordnance design."

One regrets, however, that he had limited himself to these terms of reference, for the chapter on "Motorized Material" is so curtailed as to make one wish that it was not confined to designs of an admittedly permanent nature.

R.H.A.

GREAT BRITAIN IN EGYPT.

By Major E. W. Polson Newman.

(Cassell & Co., London, 1928.)

Half a century has passed since the Khedive Ismail Pasha abdicated in favour of his son Tewfik Pasha, and many of those who took part in the events of that time and of the first years of the British Occupation of Egypt have passed away. It is both useful and fitting that the story of Egypt's recovery from bankruptcy, and her rise to prosperity, should be told, and should be shown in their relation to the conditions which prevail to-day. Much now existing has its origin in those early days and cannot be fully understood without a knowledge of the events of that time.

Major Polson Newman does this very effectively and impartially, pointing out the many difficulties inherent in the situation, the mistakes that have been made from time to time, as well as emphasizing the ever-changing political and social conditions in the country which have repeatedly made any solution more difficult.

Ismail Pasha's reign began under favourable conditions, since the public debt did not exceed three millions sterling, and the revenue was easily collected, but by 1876 the public debt exceeded 94 millions, and the revenue was only collected with the greatest difficulty. In his desire to make Egypt a modern State, he spent vast sums of money and continually raised loans to pay off the interest on previous debts, until European intervention became inevitable. To meet the interest due for the various loans, the arbitrary methods of tax collection which had been practised since the days of Mohammed Ali were ruthlessly applied, until the fellahin were reduced to extreme poverty. The discontent in

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the country was matched by the complaints of the Egyptian officers of the Army that all the higher posts were held by Turkish and Circassian officers to their exclusion. It was under these conditions of universal discontent that the outbreak headed by Arabi occurred. At the time, it was held to be and was treated as a military revolt, but the author maintains that it was really a national movement to free the people from the intolerable burdens due to the Ismail *régime*. That it began in the Army was determined by circumstances, and it may well be that, had the situation been recognized as a popular movement, it might have been dealt with in such a way as to avoid at least some of the difficulties which subsequently arose. The whole story of the Arabi revolt is treated well and impartially, the various influences at work being clearly indicated.

After the rout of the Egyptian forces at Tel el Kebir and the taking of Cairo, the British occupation of Egypt was an accomplished fact, and Great Britain became responsible for the reorganization of the country. The choice of Lord Cromer to direct this was a particularly happy one, and in the course of twenty-four years Egypt under his guidance passed from bankruptcy to solvency, and thence to such a condition of wealth and prosperity as she had not known hitherto. This is well and clearly described, as well as the many difficulties incident in the situation, such as the extra-territoriality enjoyed by all Europeans under the capitulations. But gradually taxes were reduced, forced labour (corvée) was replaced by paid labour, municipal and provincial councils were instituted to deal with local affairs.

Under such circumstances, a politically young community naturally desired to have a share in the management of its own affairs, and, though it was an essential part of Lord Cromer's scheme that this should be so, progress in this direction seemed slow to those whose knowledge of administration was theoretical rather than practical. The growth of nationalism in Egypt is clearly sketched and its aims are indicated.

The outbreak of the World War seriously affected the situation for the worse, for though at first Egypt was not greatly affected, many of the British officials with long experience of the country left to take up War service in Europe. The declaration of a Protectorate in 1914, the extension of the War to the Eastern Mediterranean and the Palestine campaign, together with the repercussion of these and other events related to them on the people of Egypt are well described, and the numerous causes and their effects are critically discussed.

After the War, Egypt, like many other countries, suffered from considerable unrest, which was actively fomented by Nationalist extremists and serious anti-British disturbances ensued. The final chapters of the book give a very interesting account of the various phases of the Egyptian situation during the last ten years, which cover Lord Allenby's High Commissionership, Lord Milner's Mission, the recognition of Egypt's independence, and the accession of King Fuad, who succeeded his uncle, King Hussein. A good many awkward situations have arisen, but they have been dealt with, and at the present time the earnest endeavour to reach an agreement acceptable to reasonable persons of both countries has made considerable headway. The Declaration of 1922 and the "four reserved points" still govern British policy, and anyone who wishes to

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gain a clear idea of the present position can be recommended to study the history of the relations between Great Britain and Egypt, as they are set out with great clearness and fairness in this book.

H.G.L.

EMBATTLED BORDERS.

By F. ALEXANDER POWELL.

(John Long, Ltd., 16s.)

This is a book which is well worth while. Written by a distinguished American novelist and globe-trotter, it may cause some to remember the famous case of the M.P. who travelled from Bombay to Calcutta, and who then wrote a history of the inhabitants of India. But Alexander Powell has some intuitive gift, and in *Embattled Borders* he has presented in most readable and clear form the main racial, political, and national problems which beset post-war Europe. Czechoslovakia, Yugo-Slavia, Esthonia, and Finland are to most of us names. We know that the Czechs do not like the Croats, or is it the Albanians, or the Moravians? Are the Esthonians a kind of offshoot of the Lithuanians? What happened in Hungary immediately after the War, and why does Admiral Horthy call himself a " regent " ? The Treaties of Versailles and of the Trianon carved up Europe in an inexplicable manner, and now in 1929 we want to know how it is all working. Are those ethnographical boundaries likely to stand the test of time, or are minorities so seething with discontent that another European upheaval is likely? This book gives one to think. It is the work of a keen observer, and of a man who apparently possesses the " entrée " to most of the inner sanctums of the present rulers of Europe. Signor Mussolini, Marshal Pilsudski, Herr Masaryk, and Herr Sahm, at any rate, thought fit to grant him interviews, to mention only a few.

Books which have appeared since the War which deal with the whole of the main problems of Europe are few and far between, and they are usually deadly dull. *Embattled Borders* can be read like a novel, and will certainly not be put down until the last page is reached.

To judge of its accuracy of statement is not, of course, so easy, but Chapter VIII, which is entitled " The resurrected land," deals with the complicated problem of Poland, and in particular her relations with the Free State of Danzig, and also explains the situation in the so-called Polish Corridor between East Prussia and Pomerania; Chapter VIII in the reviewer's opinion is about as clear and truthful an exposition of those particular problems, of which he has first-hand knowledge, as one could wish for; and it seems fair therefore to assume that the views expressed in other chapters dealing with other countries are likely to be as closely allied to the truth.

Officers of the Corps will read with pleasure the remarks by this American writer, who is no anglophile let it be said, on page 276, in which, *apropos* of the Polish police force, he says, " thanks to the efforts of a British Mission, the police are as smart and nearly as efficient as London

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bobbies." That Mission was commanded in 1919 by a quite junior R.E. regular captain and brevet major, camouflaged as a Brigadier-General.

On the very important question of "Anschluss," or the tendency of modern Austria to unite with Germany, the author is extremely interesting (Chapter VII), whilst Chapter VI, which deals with the problems of Czechoslovakia, is an absolute mine of information. The famous Land Act of April, 1919, which was so cruelly unjust to Germans and Hungarians left to the newly-formed State, is explained at some length (pages 217–225), and one is left in no doubt as to how far westward the tide of communism lapped.

Chapter I is a masterly description of present-day Italy. Chapter IV, "The Danger on the Danube," is interesting, but it contains one rather stupid reference to so-called "inner history" (pages 154, 155), though the author has the grace to say the story is in no way authenticated.

Racial antagonisms are the causes of wars. It behoves every soldier, therefore, to learn all he can of such antagonism, and of the problems which are at the root. *Embattled Borders* is the most readable book on European problems that has appeared since the Great War.

P.K.B.

FIELD-MARSHAL EARL HAIG.

By BRIG.-GEN. JOHN CHARTERIS, C.B., D.S.O., *M.P.*

(1 Vol. 8vo. Cassell. 25s. net.)

(*By the Hon. Sir John Fortescue.*)

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This is an exceedingly good book. Arrangement, proportion, language are all alike excellent, and the craftsmanship is so fine that it has the supreme merit of appearing unconscious and effortless. Inevitably the background of the central figure consists of a tangle of complicated military operations, but these are skilfully unravelled and disposed in broad, clear, simple lines, so that a very few rough maps suffice to explain them. No one who has not tried to accomplish the like feat himself has any conception of its difficulties; and the apparent ease with which General Charteris has surmounted them makes one understand the better the intense labour which he has thrown into his task. Lastly, the tone of the whole volume is exactly suited to the subject. It is modest, restrained, and straightforward, the story of an officer and a gentleman told by an officer and a gentleman. Very respectfully I presume to offer General Charteris my congratulations.

There are no figures in British military history which can be set up in comparison with Haig's except those of Marlborough and Wellington. He was widely different from either, though with Wellington he had some remarkable points in common. We see Haig first as a small boy of ungovernable temper; and he drifts through life at public school and university, aimless, discontented, solitary, and somewhat Olympian. Then, rather later in age than usual, he goes to Sandhurst and discovers his life's work—the study of the art of war. He enters a very good

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cavalry regiment, and, since he is beautifully made, very good-looking, meticulously careful in his dress, and an excellent horseman, we expect to see him expand a little. But no! He remains solitary and aloof, holding everyone still and always at a distance; and so, indeed, he remained to the end of his life.

The truth is that he was by nature very shy and very emotional, and that his whole life was spent in crushing and holding down these emotions. Wellington was exactly the same; and both occasionally broke down. Wellington was painfully shaken at the funeral of Somers-Cocks; Haig abandoned his routine for half a day when John Gough was killed. Wellington galloped for miles to creep in by stealth and kiss an officer who was thought to be dying; Haig openly embraced the doctor who told him of the birth of his son and the welfare of his wife. Both commanded deep affection from those about them; neither of them returned it nor pretended to return it.

Their training was widely different. Wellington had to do with politics and parliaments at a very early age, and even thought of abandoning a military for a civil career. Haig detested politics and devoted himself wholly to the study of his profession. For him, as for Foch, literature and art had no attractions. (Wellington was a lover of music.) But the study of war is by no means so narrow a field as is generally supposed. It is really less a matter of strategy and tactics than of broad human nature; and as such Haig understood it. He thought out questions with intense concentration, formed his opinion, and thenceforward clung to it with vehement tenacity. A new fact might make him revise that opinion, but not a new view of old facts. There again he resembled Wellington. Neither would argue, and neither would give way one inch. And the strange thing was that, though Haig could set forth his thoughts admirably on paper, he could not for the life of him express them with his tongue. He was incredibly inarticulate. General Charteris emphasizes the fact, but I could not without experience have realized the full extent of it.

With the loquacious of all professions— the Lloyd Georges and the Henry Wilsons— such a man was at a disadvantage. He had, moreover, an instinctive aversion from many words, looking upon them as mere impediments both to thought and action, and he was especially impatient of debates which issued in no decision. He mistrusted Mr. Lloyd George at first sight; and Mr. Lloyd George, instantly conscious of the fact, naturally retorted, if not with immediate mistrust, at least with immediate dislike. Haig's rigidly, frigidly Olympian courtesy must have been more disconcerting than a thousand polished speeches; and it is not surprising that the relations between the two men were the reverse of cordial. Nevertheless, Haig shared Wellington's strongest point, the sense of duty and discipline, which made him bow always to the ruling of the supreme civil government; and he strove steadily to make the best of its orders. If the War did bring forward one great man, it was Haig. Strong, silent, much enduring, he saw further and more clearly even than Foch, and his masterful will prevailed. His trials and troubles, his successes and mistakes, may be read in this book. Let me note only two facts. The British, though defeated in March, 1918, were not

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demoralized. Though there were serious mutinies in the armies of every one of the great continental powers engaged in the War, there was none in the British Army. Haig, deeply impressed by religion rather late in life, had a strange exalted (if one may use the term of so sane a man) idea that it was his mission to lead the British Army to victory in that War; and this persuasion cannot have been without its unconscious influence. It made itself felt by sheer force of character. He had no nickname. He was not the darling and the deity of his troops as had been Corporal John. But he was trusted fully, firmly, faithfully, and he was worthy of the trust.

THE WORLD CRISIS.—THE AFTERMATH.

By THE RT. HON. WINSTON S. CHURCHILL, C.H., *M.P.* Maps and Plans. (Thornton Butterworth, Ltd., 1929. Price 30s.)

This, the last volume of the series entitled *The World Crisis*, is probably the most valuable portion of Mr. Churchill's stupendous work. In his earlier volumes, the unsoundness of Mr. Churchill's arguments in the domain of strategy and his biased judgments on the men who won the War detracted greatly from the value of his writings. In this volume he is on firmer ground when he describes the inner history of the drafting of the Peace Treaty and the events which took place in the years following the Great War. Thanks to his inside knowledge, he is able to give us an intensely interesting account of the drafting of the Treaty of Paris, our intervention in Russia, the Russian Civil War, the Irish Settlement, and the War between Turkey and Greece. His chapters on these events contain much that is new even to the careful reader of the contemporary Press, and will have a lasting value when the history of the period comes to be written.

From beginning to end the book is well worth reading, and will give the reader a much clearer insight into the march of events than anything that has been written since the War.

H.B.-W.

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1929).—"*La division Exelmans le 28 août*, 1914," by Capitaine Minart, is completed in this number. This instalment describes the gallant counter-attack of Exelmans' 35th Division against Guise and its retreat after the attack had apparently failed. Actually, Général Exelmans' action had the effect of holding up General Von Bülow's Second Army, and so allowed the French, under Général Lanrezac, to get away, but this was not clear to the unfortunate Division, who suffered terribly heavy losses. There has been much discussion as to whether Général Exelmans was right or not in attacking, as he had been ordered to retreat, but from reading the article, one cannot but agree with the

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writer that he could not be blamed, although perhaps his attack was rather hasty. Général Lanrezac himself considered that the action was correct, according to Général Exelmans' own knowledge of the circumstances. The article is well written and easy to follow, as there are not too many sub-units mentioned.

"*Les populations du Maroc*," by Capitaine Loup, is a short description of the tribes which inhabit Morocco. The basis of the population is provided by the Berbers, who are the ancient stock who fought against Rome, many centuries ago. The other important tribe is the Arabs, another Moslem stock from the east; in addition, there are Moors, Jews and negroes. The writer's object is to make it clear that the Berbers are the most important, and that they will only yield to the civilizing influence of the French, not to pressure from the Arab civilization and doctrines of the Koran.

Lieut.-Col. Grasset continues "*Montdidier, le 8 août, à la 42e division*," in this number. He deals with all the final preparations for the great attack, in which the French 1st Army, of which the 42nd Division was on the left, came under the orders of Sir Douglas Haig. The preparations are given in great detail, but Col. Grasset does not forget the humorous side of the mass of moves which had to be carried out, and he is also extremely pleased with the co-operation of the Canadians, on the left of the French, who did everything they could to ensure the support of the 42nd Division, including the loan of a section of tanks. The most intense secrecy was observed, but all the same, everyone knew that an attack was in the wind, including the enemy, although it turned out to be of little advantage to the latter. Good sketch maps are given.

"*La rupture du front de Salonique en* 1918," by Général Kalafatovitch, consists of a lecture given in 1928, on the occasion of the celebration of the tenth anniversary of the Salonika victory, with a foreword by Général Franchet d'Espérey. It is a short but most interesting description of a really marvellous campaign. The Serb sector, in most difficult country, was selected by Franchet d'Espérey for the break through, and in six weeks the Serbs averaged ten kilometres a day, a most amazing performance.

"*Le salon d'automobile en* 1928," by Lieut.-Col. Doumenc, comprises a bird's-eye view of the Paris Motor Show. Not only were all types of car and lorry to be seen, but demonstrations of radio-photography were given. The writer discusses the advance of the Diesel engine as a new type of motive power which may be introduced commercially in the not too distant future.

(*February*, 1929.)—Lieut.-Col. Grasset, in continuing "*Montdidier, le 8 août, à la 42e division*," describes the first advance of the division, who met no opposition to start with. The various preparations were only made just in time, but everything was ready by zero hour. Although the Germans expected an attack, they evidently did not know the day, as they were surprised by the appalling outburst of shell-fire which broke out at 4.20 a.m. on 8th August. The instalment closes with the appearance of the dawn of a beautiful day shortly after the launching of the attack.

In this instalment of "*De l'ancien au nouveau règlement du Service de*

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Santé," Médecin-Général Uzac discusses the effect of typhoid, influenza and typhus during the Great War. The effect of inoculation in reducing typhoid and the appearance of influenza in 1918 are well known, but he also draws attention to the appalling results of typhus, which broke out in the Balkans during the latter half of the Great War.

"*Une heure tragique de Napoléon,*" by Général Camon, describes a little known period in the Emperor's history, when he was actually imprisoned at Antibes, near Nice. The French armies had been on the defensive in Italy, and Bonaparte was anxious to revert to the offensive and clear the Austrians out of north-west Italy. He succeeded in convincing the younger Robespierre, who went to Paris to put Napoleon's views before the Committee of Public Safety, but the *coup* of 9th Thermidor followed and Napoleon was actually imprisoned, by order of Carnot, who had driven out the elder Robespierre, and hated the idea of an Italian offensive. However, Bonaparte was released and finally received permission to carry out his plans, which he did with remarkable success.

In "*Une journée de crise à la 3e armée allemande,*" Col. Rozet describes the situation on the Meuse on 28th August, 1914, when both Von Hausen, commanding the German 3rd Army, and the left of the French 4th Army were in a state of considerable overstrain. Von Hausen's Army had been marched off its feet, and was suffering from appeals from the German Armies on either flank, while the French were having great difficulty in extricating themselves. Both sides had the chance of striking an effective blow at the other, but neither knew the situation well enough for the blow to be delivered. As the writer points out, this is not an unusual situation in war.

Capitaine Marchand begins "*La vocation coloniale de la France,*" in this number. He describes the great French empires of the past, as built up first by Louis XIII. and XIV., and again by Napoleon I., and how, in each case, they fell to the ground. It was intense Catholicism which was more effective in killing the first empire than any other factor, while the loss of the command of the sea was fatal to the second. The writer then describes how the present empire was built up and points out how its preservation depends on the might of France at home. Had she lost the Great War, it is clear that her empire would again have been torn from her. Security at home and the colonizing spirit are essential for the maintenance of great overseas possessions.

(*March,* 1929.)—In the fourth instalment of "*Montdidier, le 8 août, à la 42e division,*" Lieut.-Col. Grasset describes the capture of the Bois de Moreuil. The progress of the French was not quite according to plan here, partly owing to the Canadians not being up on the left, but with the aid of a British tank the operation was finally completed. The story is again given in great detail.

Médecin-Général Uzac completes "*De l'ancien au nouveau règlement du Service de Santé,*" with a technical discussion on the treatment of different kinds of wounds in war. One of the great difficulties during trench warfare was the effect of dirt on ordinary wounds and fractures, but considerable strides were made in dealing with these difficulties. The writer ends by pointing out that an efficient medical service is an

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important branch of the army as well as the various other factors which go to build up success.

"*Une documentation nouvelle sur la campagne Polono-Russe de* 1920. *Le livre du Général Sikovski*," by Général Faury, appears in this number. This is a most interesting account of Général Sikovski's book, which describes, from first hand information, the events of the War between the Bolsheviks and the Poles. This War is one little known to the British public, and as Sikovski commanded a Polish Army, his book invites attention. At the outbreak of the War, the Poles tried to guard their frontier with a line of posts, while the Bolsheviks delivered a concentrated attack. The posts were naturally unable to withstand the attack, the Polish forces retreated hurriedly and the Bolsheviks nearly reached Warsaw. Fortunately, Marshal Pilsudski, supported by General Weygand, who had been sent to Warsaw by the French, saw that linear defence was of no use whatever where insufficient numbers were available. Pilsudski therefore allowed the Bolsheviks to sweep on north of Warsaw, while he reorganized his forces and struck them from the south. This blow came as a complete surprise and the Bolsheviks were utterly routed. It needed another battle to complete their defeat, but the main work was done north of Warsaw. The campaign is well worth studying as showing the effect of vast areas of country on comparatively small armed forces, as it must be realized that the Bolsheviks were only able to employ a small proportion of their man-power in this war.

Capitaine Marchand completes "*La vocation coloniale de la France*," in this number. He looks forward to the day when France will be animated by the same spirit as Great Britain all over the world, and he thinks that this "imperial" spirit has already begun. The effect of the Great War, which brought many more square miles under French dominion, has made the imperial outlook all the more necessary, and the writer shows what has been done already in the government of the colonies and by the reduction of distances by modern means of locomotion. It is pointed out, however, that France depends largely on the African man-power to protect herself against further attacks from the north-east, a situation which does not exist in Great Britain. H.A.J.P.

COAST ARTILLERY JOURNAL.

The December number (1928) contains an article on "The World Situation in Coal and Iron," in which the writer points out that an estimate of the world's coal resources, made by the International Geological Congress in Toronto in 1913, shows that the American Continent possesses five or six times the total resources of the British Empire in coal. The minimum thickness of seams considered were 12 inches down to 4,000 feet, and 24 inches between 4,000 and 6,000 feet of depth. Working coal at depths greater than 5,000 feet is not economical owing to cost: in fact, a Royal Commission on Coal Supply in 1905, put the lowest level at which coal could be got advantageously in England as 4,000 feet.

The largest carboniferous field in the United States extends through

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Western Pennsylvania, Eastern Ohio, Western Maryland, West Virginia, Eastern Kentucky, and the State of Tennessee to Central Alabama. The area, in fact, which was the original home of the coon song. It is 875 miles long by 30–180 miles wide.

The Congress considered that the world's ultimate coal supply will last for some 3,000 years.

As regards iron ore, the United States is said to produce about 33 per cent. of the world's supply, the Lorraine field of France producing about 25 per cent.

In the January number (1929), there appears an article on mechanization as being evolved in the U.S. Army. Last summer, the Experimental Mechanized Force was born at Fort Leonard Wood, but it was found to answer to the title of a Motorized Force, rather than a Mechanized Force, as the tanks which could travel under their own power were not fast enough. The force included light and heavy tanks, infantry, field and anti-aircraft artillery, engineers, signals, chemical warfare service, armoured cars, ammunition train, medical corps and motor repair units, with the addition of air units for certain exercises. Altogether, about thirty different makes of old and new commercial vehicles.

At first, sections composed of about fifty vehicles made preliminary marches of about fifty miles: later, the whole force made marches up to the maximum of 420 miles. Unit and combined tactical training was carried out between the marches, to find original solutions for the various problems, without the benefit of precedent.

Deductions made from the exercises showed that the entire force must be able to march and manœuvre at a much more definitely high speed, and that air units need not form part of the Mechanized Force itself, but should be attached as required for a specified object. As all "non-combatant" vehicles need combatant elements to protect them, they must be eliminated as far as possible, and self-propelled elements substituted for them. A proposal was made for a 3-in. A.A. gun, mounted on a fast chassis, to be recognized as the unit of field artillery as well as for A.A. duties. This would necessitate a double training for each crew, as well as the provision of all the mechanical details essential for both *rôles*.

One solution for the organization and administration of the future Mechanized Force is to divorce it from the other arms and make it into a glorified Tank Corps, comprising all formations: the advantage of this suggestion lies in the fact that the whole of the interdependent training would be co-ordinated by one commander.

This number also contains a very interesting historical account of the Colonial Coast Forts on the South Atlantic Coast of the United States, beginning from the times of the original Spanish claim to the whole continent, based on the Papal grant following the discoveries of Columbus. If Spain had only kept quiet about the whole discovery and had set to work steadily to colonize and populate the new possessions, she might have had a more consolidated hold on all the best landing places and ports of the future before the English adventurers were able to oust them. But they made the additional mistake of antagonizing the natives by decoying them on board ship and carrying them off to be sold as slaves, while

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religious bigotry earned them a reputation amongst the other white nations which was never forgotten. When the Spanish Commander captured the French Fort Caroline in 1565, he put the Huguenot garrison, men, women and children, to the sword, and left an inscription on the site: "Not because they were French, but because they were Lutherans."

An article on "Camouflage for Artillery" describes the scientific method of blending colours. The author looks upon camouflage as a counter-intelligence service, designed to defeat or neutralize the intelligence gained by enemy observers. The observer who is the most difficult to lead astray is the aerial photographer, who is provided with a good camera. In the case of a large position on the ground, such as some concrete defensive post or battery, the best result can be obtained by using the five-colour system. This depends upon the scientific blending of brown, yellow, green, cream and mauve, with a narrow dividing and border line of black. This dividing line has the effect of impairing the line of vision. The mass of the position is thus broken up into fragments and the eye of the observer is compelled to record the portions painted green and brown, while it fails to record the portions painted cream and mauve. Yellow is used to counteract shadow. The camera can be defeated by a suitable chemical preparation of the pigments which upsets the results obtained through ray filters. The cream and mauve portions give the appearance of being on different planes to those parts coloured green and brown, so that the information recorded is false. The writer affirms that even when viewed or photographed from low altitudes, the reality is hidden by this five-colour system.

A photo taken by a stereoscopic camera is rendered untrue by the scientific application of the laws of light and colour, by the use of opaque pigments for the nearer planes, by the employment of mauve in juxtaposition with its complement and yellow for the neutralization of shadow. There are certain chemically-prepared ray-proof pigments which interfere with the normal action of the rose filter. This filter is used to turn green pigments to rose colour while leaving natural foliage green.

A definite silhouette, such as that of a big gun, can be broken up by means of fins bound to it, which are cut out to resemble the shape of foliage.

The writer then passes to the normal use of camouflage in the form of coverings and dummies. For use in connection with smaller screens or nets, the three-colour system with green, yellow and cream only, but separated by irregular heavy black masses, instead of lines, will be found to be the most satisfactory. The five colours are necessary only for large surfaces. It is easier to hide a battery in a position where more than one uniform colour generally exists, than on a flat equable desert, because in the former case the exact shade of colour of the covering is unimportant. Both during and after the construction of the disguise, very strict camouflage discipline is indispensable, for it is then that the real trouble is beginning.

The same number contains a description of the new plant for the production of helium for airships by the Amarillo Oil Company at Soncy, about six miles west of the city of Amarillo, in the Panhandle district of Texas. It seems that the existing Petrolia field, in Northern Texas, is

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now in the last stages of its life, after producing gas for more than twenty years. The gas from the new field is said to be twice as rich in helium as that from the old field. The three gas wells already driven, produce 27 million cubic feet of gas per day, and a fourth well is being opened.

The helium is recovered by cooling the gas to approximately 300 degrees below zero, at which temperature all the constituents but helium are liquefied, thus permitting the helium to be drawn off as a gas for compression into storage cylinders. This low temperature will be produced by compression and the subsequent expansion of the gases. At the minimum temperature, atmospheric air is a liquid, carbon dioxide and mercury are solids, lead and copper have the properties of steel, and rubber is as brittle as glass. The United States is the only nation, as far as is known, having sufficient resources of helium to develop a commercial supply. Before the War, the cost of production was about £400 a cubic foot, now it is in the neighbourhood of a few shillings.

The February number continues the historical survey of the Early Coast Fortifications. Towards the close of the eighteenth century, the threat of war with Great Britain, growing out of disputes over unsettled boundaries and over the alleged English ill-treatment of American seamen, turned the thoughts of the youthful American State from the backwoods to the undefended seaboard. As very strict economy was necessary, the earliest conception of defence for the coastline consisted of an earthen battery and, behind it, a redoubt or large blockhouse, to be used as a barrack for the garrison and a keep protecting the battery from the land side. The batteries were armed with 24- and 32-pounders. As the only garrison seems to have consisted of gunners for the battery, the method of meeting an attack was novel. If the guns were able to keep the enemy at bay, all well and good: but if the attackers managed to land for a close assault, the gunners would retire to the keep, take up the small arms provided for the purpose and act as infantry till the assault had been repulsed, and the enemy forced back to the sea, when they would resume their original *rôle*.

From the September number was given an extract from an article on the Tacna-Arica question.

In *The Times* of May 3rd, 1929, there appeared the following despatch: "Lima (Peru), May 2: The settlement of the long-standing Tacna-Arica dispute is officially announced here to-day. It is understood that the province of Tacna will go to Peru and that Arica will go to Chile, with the establishment of a small port there for Peru (*Reuter*)."

It will be remembered that the United States had been asked to adjudicate this vexed question, and that, after a very carefully thought out attempt, General Lassiter, of the U.S. Army, had reported that a fair plebiscite was quite impossible to obtain. Peru thereupon turned to the League of Nations. Evidently the thought of world-wide publicity was enough to modify the sentiment of Chile. Direct negotiation was preferred and has led to a fifty-fifty division of the coveted area.

Thus, of the territories as distributed before the war of 1880, Chile has gained Antofagasta from Bolivia and Iquique and Arica from Peru. Bolivia has lost all footing on the sea coast and Peru has lost 150 miles of it.

D.M.F.H.

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REVUE MILITAIRE SUISSE.

(1928. Nos. 7 to 12 inclusive.)

L'aviation militaire en Tchécoslovaquie. This article is contributed to No. 7 of the *Revue*, by Lieut E. Naef, who points out therein that the Republic of Czechoslovakia has paid considerable attention to the development of the "Fifth Arm," and, with a view to being independent of foreign sources of supply for the purposes of military aviation, has sedulously fostered the national aeronautical industries. At the beginning of 1928, all the machines in use, and also their motors, were of home manufacture. The peace establishment of the Air Force consists of 25 squadrons, viz., 10 fighter squadrons (of 15 machines each), 12 observation squadrons (of 15 machines each), and 3 bombing squadrons (of 12 machines each). Particulars regarding the types of machines in use and the organization of the Czechoslovakian Air Force are given in the original article.

Le commandement Français au début de la guerre Européenne. This article appears in Nos. 8 and 9 of the *Revue*, and is contributed by Col. F. Feyler; the information contained therein is drawn principally from *Les armées Françaises dans la grande guerre, tome 1er.* Col. Feyler points out that from the date of the signing of the Treaty of Frankfort, 1871, the French General Staff had the menace of another war with Germany in the near future constantly before it. In consequence, at various dates between 1875 and 1914, no fewer than 17 mobilization plans were drawn up by it. In the first part of the article (in No. 8), the developments in the international situation up to the outbreak of the Great War are very briefly sketched, and an appreciation of the military situation, from the French standpoint, is given. The second part of the article deals with the steps taken in France, immediately prior to the mobilization of the army; the occupation of the Duchy of Luxemburg by German troops; and the appointment of Joffre as Commander-in-Chief of the French Army. An outline is also given in this part of Plan XVII, which provided for the concentration of five French Armies on the Franco-German frontier line between Switzerland and Belgium.

La défense anti-chimique chez les nations armées et les perspectives du modernisme militaire. The article under this title, which is in three parts, appearing respectively in Nos. 9 to 11 inclusive, of the *Revue*, is contributed by M. S. de Stackelberg (an engineer) and Dr. D. Zweit (a chemist), who point out that war is no longer confined in its aims to narrow dynastic and political interests, but has now taken the form of a relentless conflict for the preservation of national existence. The desire to secure decisive results in the shortest possible time has been accompanied by two marked phenomena: (*a*) the disappearance of the relatively shallow fronts of opposing armies—due to the great range of aerial attacks; and (*b*) the disappearance of non-combatants or civil population, in a juridical sense, by reason of the necessity of mobilizing the entire people of a country for work essential for the conduct of military operations on a big scale. This fact is clearly recognized in the law for the organization of the nation in arms recently passed in France. In consequence, the whole of the national territory has become

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a " front de combat," and the distinction between combatants and civil population has ceased to exist.

Air attacks and chemical warfare are, the authors of the original state, destined to become the weapons for relentless and indiscriminate use by the dominant arms in a future war, and they urge therefore that this fact should be brought home to the masses of every nation, and also that citizens at large should be familiarized with the defensive measures suitable for meeting chemical warfare waged against the civil population.

In the first part of the article (in No. 9), a reference is made to the abortive Conference assembled at Washington in 1921, for the purpose of prohibiting chemical warfare. Some particulars are also furnished regarding the provisions for the conduct of chemical warfare made in the United States of America and in Japan. The second part deals with the situation, as regards chemical warfare, in Europe; the measures which have been adopted in relation thereto in France, Poland and Russia are also briefly reviewed. In the third part, a table is given showing the casualties inflicted during the Great War by gas attacks, artillery fire, trench weapons, mines and hand grenades; summarized the results were as follows:

	Wounded.	*Killed.*
Gas attacks	6·5%	1·5%
Artillery and other weapons ...	5·5%	30·0%

The authors of the original article are of opinion that promiscuous chemical warfare cannot be prohibited, and put forward certain suggestions as regards the defensive measures which should be adopted to meet it; they also publish the proposed articles of a code in connection with the protection of civil populations against gas attacks, which code they have named the " Violet Cross " Convention.

La guerre Européenne. The original article is contributed to No. 11 of the *Revue*, by Col. F. Feyler. After passing in review the information contained in some of the more important volumes relating to the Great War, Col. Feyler proceeds to discuss the question: Would it have been possible to avoid the armed conflict of 1914–1918? The conclusion which he arrives at is that, after the Sarajevo incident, the Austro-Hungarian Government was bent upon bringing about the humiliation and submission of Serbia by violence, rather than by resort to the slower methods, of which the issue was uncertain, of diplomacy.

Dealing with the diplomatic campaign for the " localization " of the conflict, Col. Feyler takes the view that the desire for the " localization " of the Austro-Serbian differences was not less in one of the camps than in the other, but there was considerable divergence on the subject in relation to the method to be adopted for realizing the desired end. Whereas, those who followed the lead of Sir Edward Grey hoped, by securing " localization," to ward off the general conflict likely to be born from a regional war, and endeavoured, therefore, to bring about a reconciliation of opposing interests by preventing even the outbreak of a regional war; on the other hand, the Central Powers looked at " localization " from the standpoint of obtaining for Austria an oppor-

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tunity for trouncing Serbia, without any interference on the part of the latter's friends.

Col. Feyler points out that the information available for dealing fully with the origin of the Great War, both in its immediate as well as its remote political bearings, is still far from complete; some of the diplomatic correspondence which has been very recently published has filled up some of the gaps, and when the further diplomatic correspondence, which is being now got ready in some of the Continental countries for the Press, is made public, it may be possible to deal with this difficult subject comprehensively.

W.A.J.O'M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1928. TOME II.—NOS. 4 TO 6 INCLUSIVE.)

Les opérations de l'Armée Belge. 1914–1918. The authors of this series of articles consider it desirable, before entering on the narrative of the active operations during the period of trench warfare in Flanders, to deal with matters of an administrative nature. The two parts of the article which appear in Nos. 4 and 5, are devoted to the various steps taken in relation to the reorganization of the Belgian Army during the War period. No. 4 of the *Bulletin* contains an outline of the special legislation brought into force to meet the wastage of war, and for the purpose of providing for the expansion of the Belgian Army in view of the greater effort demanded to cope with the magnitude of the task imposed upon the Entente Powers by the Central Powers. The numbers of men enrolled under the special ordinances at various dates are set out. The steps taken for training officers and other ranks; the measures adopted for the acquisition of war material; and the developments brought about in the armament and equipment of the Belgian Army are also dealt with in No. 4.

A brief description of the organization of the Belgian Army as it was in 1914, is contained in No. 5 of the *Bulletin*; the successive changes introduced therein during the continuance of the War are also described in considerable detail, and in a form to show at a glance how very considerable were the increases which took place in the case of the technical troops.

An account of the Lines of Communication services during the period of trench warfare appears in No. 6 of the *Bulletin*. The general situation is first sketched out; later, particulars are given relating to the supply services; to the Ministry of Supply created in February, 1916; to the ordnance services; artillery establishments; the utilization of the engineers on various technical services, *e.g.*, forestry, mining, quarrying, etc.; and engineer supplies.

Du rôle de l'armée de campagne et des forteresses Belge en 1914. The final part of the article under this title, contributed by Lieut.-Col. Duvivier and Major Herbiet, appears in No. 4 of the *Bulletin*. The authors point out that, when the Great War broke out, the military preparations in Belgium to meet a sudden attack, such as that launched against it by Germany, were far from complete. Nevertheless, the Belgian troops fought with courage and tenacity, but they did not

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possess any manœuvring power, nor were they capable of undertaking offensive operations on any scale. Consequently, if the comparatively small Belgian Army only yielded ground in its retreat from Liège to the Yser, step by step; if it faced a powerful enemy for three months and managed to escape disaster; if, by its activities, it caused the enemy to divide his forces, and, therefore, to be unable to display his full strength at the decisive point; if this small force managed to hold together until it made a junction with Belgium's Allies, and was able to raise its standard aloft on the Yser with the cry: "*On ne passe plus*," these results were alone achieved thanks to the great part played by the Belgian fortresses.

Appendices are annexed; they give particulars of the German forces which were detached to meet the menace of the Belgian Army during the progress of the frontier battles, during the period immediately subsequent thereto, and during the Battle of the Marne. A table is also given, setting out in a summary manner the references contained in German publications in relation to the influence exerted by the Belgian forces on the operations of named German formations—the titles of these German publications are recorded.

Historique du Génie. The third and the final parts of the original article under this title, by Lieut.-Col. Coppens, appear respectively in Nos. 4 and 5 of the *Bulletin*. Part 3 is devoted to the vicissitudes of the engineer arm during the ascendancy of the Vallières, father and son, and to the history of the arm during the periods of the French Revolution, the Empire and the Restoration. The elder Vallière was an advocate of the absorption of the engineer arm into the artillery; owing to his distinguished services as an Engineer officer, he was given important artillery commands. The engineer company under his command was reorganized in 1718, and he was then promoted to high rank; later, he was appointed an artillery general, when one of his first acts was to bring about an assimilation of the engineers and the artillery. Various cross-currents now made themselves felt in the French Army; at one moment, the ardent reformer in the ascendant would be an officer who pinned his faith on the efficiency of the arrangement, which combined the artillery and engineers into a single Corps, at another moment the deciding authority would be an officer, or a Minister, who entirely disapproved of the fusion scheme, and, in consequence, would undo the work of his predecessor, and re-create separate artillery and engineer arms. During a part of the period in which these repeated reorganizations were in progress, Vallière junior was the Director General of the Artillery and Engineer Corps.

Further difficulties arose towards the end of the eighteenth century; the whole Army was now completely disorganized, and during the periods of the Revolution and the Empire, incessant changes were made. The engineer arm had, by this time, ceased to exist; and, in consequence, the art of the sapper and the miner had been completely lost; to such an extent had this taken place, that in 1792, at the Siege of Antwerp, it was necessary, before sending troops into the trenches, specially to train them in sapping in a small work which was conveniently placed for the purpose. The various steps taken to rectify the unsatisfactory

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state of things referred to, are set out in the original article; mention is also made of the development in the scope of the duties assigned to the engineers.

The final part of the article (in No. 5), is devoted more particularly to an account of the engineer arm in the Belgian Army, from the time it came into existence on the outbreak of the Revolution of 1830; the history of the arm is divided into three periods, viz., 1832–1868, 1868–1913, and 1913–1926, and its growth and the changes in its duties and organization, in each of these periods, are briefly traced.

Les Chars de combat. The final part of the article, by Major Liévin, appears in No. 4 of the *Bulletin*. It deals with some of the types of tanks in use in the American Army, in Spain, Russia, Poland, Czecho-slovakia and Germany. A list of the works consulted is appended to the original article, and a table is also furnished wherein dimensions and other particulars relating to tanks in use in various countries are recorded.

L'Organisation de la Défense Nationale en Suisse. An anonymous article under this title is published in Nos. 4 and 5 of the *Bulletin*. Part I deals with the Swiss Army; its organization and recruiting system are explained, and the provision made in the Estimates for National Defence is briefly touched on. In Part II, particulars are given of the method adopted for preparing the youth and manhood of Switzerland for military service. Extracts are also given from the ordinance of July 10th, 1928 (published in the *Feuille officielle militaire* of July 18th, 1928), which set out the legal requirements in relation to this matter.

Les deux batailles de la Marne. The original article, which appears in No. 5 of the *Bulletin*, is an interesting review of a work (published by Payot, Paris, in 1928) under this title, containing contributions from Joffre, the ex-Crown Prince of Germany, Foch and Ludendorff, relating to the two battles named.

Emploi de la défense terrestre contre aéronefs. The first part of this article, contributed by Major Molhant, appears in No. 6 of the *Bulletin*. In view of the fact that the Belgian anti-aircraft defence arrangements are still in an embryonic stage, as an introduction to the subject Major Molhant summarizes the French regulations, contained in *Aéronautique au combat, Livre IV—La défense contre aéronefs.* The aspects of the subject dealt with in the part of the article under review, relate to the duties assigned to the A.A. defence organization, *i.e.*, (1) the patrolling of the air and reconnaissance; and (2) protective measures and the means employed, *i.e.*, A.A. artillery, machine-gun fire, searchlights, aerial entanglements, and camouflage; and the methods of utilizing each of these means.

Les armées dans les Alpes occidentales. The first part of an article under this title, contributed by Major Delvaux, appears in No. 6 of the *Bulletin*; it contains brief descriptions of the important features of the mountain systems lying immediately to the eastward and westward of the River Rhone. Some particulars relating to the industrialization of these regions, *i.e.*, the utilization of the water power therein, are also given.

Tannenberg. D'après les ouvrages officiels Allemands. The first part

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of this article, by Capt. Vandaele, appears in No. 6 of the *Bulletin*; it is based on a monograph on the battle named, compiled by Lieut.-Col. von Schäfer (Chief Keeper of Archives), and issued by the *Reichsarchiv*. The part of the article under notice deals with the general situation in East Prussia in 1914; the recall of General von Prittwitz; the situation on August 3rd, 1914, and the plans of the new Commander (von Hindenburg) of the German forces in this region; and the engagements fought by the German XX Corps in the neighbourhood of Frankenau, Lahna and Orlau on August 23rd and 24th, 1914.

W.A.J.O'M.

HEERESTECHNIK.

(*July*, 1928.)—*Wireless Direction-Finding*, by K. Müller. This 20-page article, containing many diagrams, forms a very good introduction to the subject. It treats first of underlying principles and of the various methods.

Direction-finding is primarily an optical procedure, and consists in measuring the angle between a given object and a known direction, generally the magnetic north. If the radiation from the object is not that of light, but of Hertzian waves, we get the special case of wireless direction-finding.

At any point where such radiation is received, three definite directions are distinguishable, each of which is at right angles to the other two. These are:

(1) The direction of propagation or travel of the wave.
(2) The direction of oscillation of the electrical component.
(3) The direction of oscillation of the magnetic component.

Of these the receiving apparatus determines either (2) or (3), but generally (3), and deduces (1).

In the coils of a frame aerial, the oscillation of a magnetic field produces oscillating currents, varying from zero, when the frame is at right angles to the direction of travel of the wave, to a maximum, when the frame is pointing at the source.

It is usual to determine direction by reading, not maxima, but minima, and this for two reasons, (1) in general, sound minima are more easily determined by the ear than sound maxima; (2) in particular, because the sound intensity $\propto$ current strength $\propto$ field strength (or number of lines cut) $\propto$ *cos* the angle of inclination of the frame; and the difference between *cos* 89° and *cos* 90° is over 100 times the difference between *cos* 0° and *cos* 1°.

Methods. 1.—The Frame Aerial.

Consider a frame, rotatable about a vertical axis, being swung through 360°. It is obvious that the currents set up in it by electro-magnetic radiation from an external source, will pass through two maxima and two minima. That is, its characteristic if plotted will be two equal circles, touching at a point. A directional linear aerial has the same characteristic, while that of a non-directional linear aerial is a single circle.

In thus determining the line of travel of electro-magnetic radiation, the direction of the transmitting station found is ambiguous, as there

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are two solutions differing by 180°. This ambiguity can be avoided by using a combination of aerials of different types: thus, a frame aerial and a non-directional linear aerial, suitably coupled and adjusted as to phase, give a characteristic which is a compound of their respective characteristics, viz., a dipole and a circle. This curve is a cardioid, having only one maximum and one minimum.

An English method (Robinson), is to have two frames fixed at right angles to one another and capable of rotating as a whole. By switching, the coils reinforce or counteract each other. When signals remain of the same strength, whether the second coil is assisting or reversed, the second coil is idle, *i.e.*, the frame of the second coil is at right angles to the incoming wave. The method has the advantage of being applicable without interfering with message work. Another frame method has two frames movable independently about the same axis. The frames are placed one on either side of the minimum, and then adjusted to be on points of equal loudness, when the line bisecting the angle between them gives the direction required.

Frame direction-finding, the simplest method, has come latest into prominence, since the amplification necessary to keep the frames from becoming so large as to be unwieldy, has only latterly become available.

2.—The Goniometer.

This arrangement uses two linear aerials fixed at right angles to one another, each of which includes two coils situated axially, so that the coils of one aerial are at right angles to the coils of the other, and leave a space for an independent rotatable coil which is in circuit with detector, potentiometer and telephones. This exploring coil thus lies in the field, which is the resultant of the fields produced by distant radiation affecting the coils of the respective aerials, and plays in the field the part of a miniature frame aerial. This is the Bellini-Tosi system. If, instead of the resultant being obtained, the intensities are compared, the system is that of Marconi and Prince.

3.—The Star Antenna.

This is the original "Telefunken Clock," used by shore stations working to the German Navy. It consists of a large number of aerials, usually of the umbrella type, say, 32 to 45, laid out in a great star, and connected to a ring coil inside which a pair of movable brushes connects with the receiving apparatus.

All the foregoing methods have the same drawback, viz., that not all people have equal acoustic sensitiveness, and especially that the fixing of points of equal sound intensity cannot be learnt by everyone. Hence, optical methods are very desirable.

The first proposal to substitute sight for hearing was simple enough in theory. Two aerials at right angles to one another, had each its receiving apparatus. From the latter, rectified currents were led to a differential galvanometer, on which the correct angles were marked corresponding to a certain degree of amplification. Practically the difficulty of building, let alone maintaining, two circuits with the same degree of amplification, especially for different strengths of signals received, was prohibitive of such an arrangement.

Two visual methods are then described, the first by Watson Watt

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(this, like the other English method described above, also originating from Aldershot), and the second, by the author himself.

The former " very elegant " method has as indicator a Braun's tube, and the position of the spot of light on the fluorescence screen, showing the deviation of the kathode rays, gives a reading of the direction.

Müller's method is not only pleasing to the eye, but, as requiring only one receiver instead of two, is more practical. A glow-lamp on slip rings is fed by the amplified current received, and rotates synchronized with the exploring coil. As the minimum points are passed, the glow lamp is momentarily extinguished. If the exploring coil is driven by a small motor at not less than 10 r.p.sec., an illuminated circle is seen interrupted by two dark lines at the minima.

Sources of error are then dealt with, followed by the uses of wireless D.F., intelligence and navigation.

The Invention of Sound-Ranging. It is not surprising that last month's article on sound-ranging in the Swiss Army, the publication of which might be taken as implying some backwardness in this subject in the German Army, should call forth immediate protest.

Capt. Löwenstein writes an interesting article in which he shows that sound-ranging was not only successfully practised by the Germans, but that early in 1915, it was so far developed that there were eight S.R. sections working on a line of overlapping bases from Ypres to Arras. Sound-ranging was also used successfully for registering, and in general, the results achieved were such that the number of German stations was being increased as late as the end of 1917.

He disposes of the claim that sound-ranging started in France, in November, 1914, as the invention of the astronomer Nordmann, by quoting the wording of the State Patent taken out by himself on the 6th October, 1913 :

" A proceeding for determining the position of sound-producing objects, characterized by reception of the sound, conveyed through air, water, or the earth, at not less than three places, and by determining the differences in the times of arrival of the sounds, either by persons or by means of electrical receiving and registering apparatus."

Capt. Löwenstein also quotes from a memorandum addressed by himself in October, 1913, to the Artillery Proof Committee, in Berlin, a proposal to use microphones for listening purposes.

In October, 1914, at La Bassée, he made the first observations and measurements, which immediately brought such good results as to win over the artillery commanders of the VIIth and XIVth Corps, who at first had been sceptical. The first successful instance of the use of sound-ranging by the troops occurred in November, 1914, when the 76th F.A. Bde. located a gun in a wood south of the La Bassée Canal. Soon after this, and at a time when it was unknown to the Germans that we possessed any gun on a railway mounting, sound-ranging results had caused them to suspect the existence of such from different points being located along the Béthune–La Bassée Railway. Confirmation of the sound-ranging work was then strikingly afforded from the notebook of a captured R.E. officer, who had been employed working for the railway gun.

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During 1915, Capt. Löwenstein says, sound-ranging was "invented" on all sides. Prior to that, it seems to have been invented independently in Germany and in France. If the German patent quoted disposes of the claim on behalf of Nordmann of priority, he has still, as is the case with many inventions, a parallel claim of originality.

Thoughts about the Tasks of Weapon Technics, by Lt.-Gen. Baron Botzheim (*concluded*). In considering the tasks which, irrespective of the future, even now have devolved upon weapon-technics, the author, for reasons which become apparent later, starts with the air. He reviews in turn the means with which aircraft act upon ground targets, the nature of their action, classed according to the heights to which it is necessary for them to descend, the various types of weapon which are consequently necessary for engaging aeroplanes from the ground, the fundamental requirements common to those weapons, and, what is also a matter of special importance for the construction of A.A. weapons, the intended fire procedure. He then discusses the various methods of fire procedure against aeroplanes from the ground, from the water hose method with light-tracer ammunition, the burst of fire, and the barrage, to snap-shooting. This leads to the next important point to be cleared up, viz., the effects to be expected from the various calibres and the different kinds of projectiles. "The solid bullet from small calibre m.g.'s has little effect on a modern aeroplane, unless it happens to hit specially vulnerable parts, like the propeller, the engine, the steering-gear, or the pilot, and it generally is of no consequence whether the hole it makes has a diameter of 8, 13 or even 20 mm. Accordingly, the generally accepted idea that the troops have in small calibre m.g.'s efficient protection against direct action by hostile aeroplanes, up to 1,000 metres, is a false one. Some extent of moral effect can be conceded. Only through the use of the method of the water hose with tracer ammunition, and the assembling of several machine-gun barrels into a single weapon, can the troops hope for anything like sufficient effect through chance hits in vulnerable parts.

"Generally, it must be emphasized that nothing but direct hits by explosive shell with sensitive fuse can cause such damage that the aeroplane's flying power is prejudiced."

To what calibre the large calibre m.g.'s can be reduced, retaining the tracer, so as still to have sufficient destructive effect, is by no means certain; but the Germans have gathered the idea from abroad that 20 mm. is the limit.

The calibres of A.A. artillery are also for reconsideration, since it appears doubtful if the 7·5-cm. gun has sufficient effect against large modern metal aeroplanes.

From such considerations, two deductions are made. First, how extraordinarily complicated are the weapon-technical questions which affect the further developments of A.A. defence, and what a mass of tasks for weapon-technics in all countries awaits solution. Secondly, how pressing these tasks must be considered in the light of the increasing significance of the air-forces for the safety and existence of the states liable to be attacked.

"It is no passing catchword that air forces are universally becoming

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regarded more and more as taking the first place among the weapons to be immediately at a nation's disposal. Further requirements for successful A.A. defence are flights of fighters, a well-organized Air Observation Service, and powerful independent air forces ready to answer with reprisals."

The author recognizes that for Germany, as a compulsorily disarmed State, there is no question of air armament on such a scale as this, but he urges that immediate permission should be obtained for a sufficient number of A.A. weapons and the appropriate number of fighters to guard the country, " so long as in the immediate future no general disarmament of military air forces is decided upon and carried out," a state of affairs which he is bound to admit " would stand in sharp contrast with the existing tendency to increase military air forces urged with all means among the victor States."

After dealing with the air, Gen. Botzheim turns to mechanized armoured vehicles and the general motorization of armies. The latter he considers a quite natural development, corresponding as it does to the like tendency in civil life. In fact, the question of the complete replacement of the horse in armies depends upon the progress of motorization in civil life, in agriculture and in forestry, since the provision of purely military vehicles for this purpose on account of their high cost and the superannuation to be expected, " cannot be considered by any of the victor States— except perhaps by England, with its small professional army—much less by impoverished Germany, to which the number and type of motor vehicles in the army is moreover exactly prescribed."

The matter can, however, be speeded up, as has been done in some countries, notably France, by subsidies. Motorization of armies by means of requisitioned cars, omnibuses and lorries, will increase in any case, owing to the increased effect of hostile aircraft on railways.

In the full utilization of motor power, the most important question is that of the mechanical armoured fighting formations intended to be able to take the field as independent forces. They would also to some extent have to act as operative storm troops in connection with the rest of the army, which would further exploit the successes they gain. Besides, immediately war began, they would have the task of breaking through the frontier protection and seriously interfering with the enemy's mobilization and assembly march.

" The different possibilities of use of mechanized armoured fighting formations, on account of their great operative and tactical mobility, combined with very great offensive strength, ensuring immediate and full exploitation of operative surprise, have something so alluring to the higher command, that their full development can no longer be considered Utopian and is worthy of the closest attention."

The author then discusses the attitudes of the Great Powers towards this form of warfare in turn, starting with England and finishing with Germany. Regarding the restrictions on the latter, he confines himself to *difficile est satiram non scribere*, and, by thus falling back on Juvenal, shows that for himself the difficult is still achievable.

A list of twenty of the more important data to be considered in

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judging of the effectiveness of anti-tank and anti-aircraft weapons closes the series.

(*August*, 1928.)—*Questions of Motorization in Foreign Armies*. Taken from an article in *Army Ordnance*, September-October, 1927, by Major Quinton, United States Ordnance Dept.

1.—Tractors; Light, Medium and Heavy.

As regards light tractors in the United States Army, the present policy is to rely on the economic life of the nation to furnish these when required for mobilization. An army type has, however, been produced, the Tractor 1920, which is described as an excellent model, and which will be the standard if the present policy is changed. As regards civil types, the Fordson has been tried out and is looked upon as a good standby. The McCormick-Deering 10–20 is undergoing trials and is likely to come under the same category. A 2-ton Caterpillar that was tried failed to drag both gun and limber over difficult ground. A new and heavier model is being built.

In the class of medium tractors, civil life cannot be relied upon to the same extent as with the light tractors. A special military construction for this purpose is called Corps Tractor 1921. At the same time, Caterpillar 30 has been chosen as the civil type which may be required.

For heavy tractors, there is no type available from civil life which can anything like meet military requirements. However, a type has been chosen, Caterpillar 60, which will serve if two tractors are coupled together. Meanwhile, military trials are being made with the chassis of the Mark IX motor gun-carriage, and these promise a workable solution.

2.—Cross-Country Vehicles.

The first class of these is converted lorries. The first conversion made was the fitting of tracks of different sorts to the ordinary 3- to 5-ton lorries. The result of trials was the decision that the track lorry did not show sufficient superiority across country to the ordinary lorry for the conversion to be worth while; especially as, at about the same time, a very promising solution was found in the six-wheel lorry. With both rear axles driven and pneumatic tyres, the six-wheel type has done some splendid performances; so much so, that the principle is being extended to other classes of vehicle.

The next class is that of tractors with trailer. It was decided that the trailer should have wheels, and the type chosen, called the "1-ton trailer," has been made out of two coupled field gun limbers. The same, but built rigid, so that the two limbers make up a wagon, was not successful. It is known as the "2-ton trailer."

Class three consists of the "Tractor, ammunition wagon." It was built for the use of the Tank Corps on a light tank chassis, the Tank Corps having insisted upon an ammunition wagon, having the same ability to negotiate country as the tank itself. The next is also a special class. It consists of the Infantry light motor-lorry, with four-wheel drive and pneumatic tyres, required for carrying weapons, ammunitions, signal stores, etc., in forward sectors. This lorry has gone to the Infantry for trial.

The last of the cross-country classes is the Reconnaissance Car. It

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was originally demanded for the conveyance of the personnel of mechanized units who had previously been mounted on horseback. Several designs were made and tried, until such excellent results were obtained with the Ford cross-country car, that all trials with special cars became unnecessary, and the Ford was adopted.

3.—Tanks.

The whole position as regards tanks in the U.S.A. is curious. The 6-ton tank and the 40-ton tank had their origin in war. Since 1919, while all the other great military nations have shown great interest in this problem, the U.S.A. have produced a single type, the medium tank of 22½ tons. This tank has been tried with the troops and reported as too heavy. The Ordnance Dept. does not propose to make other than slight alterations in it during the next 10 to 15 years, but the question is being studied whether another medium tank of 15 tons should be produced.

4.—Dragons.

As regards light artillery, the decision has been reached that the horse is still preferred. Should motorization be decided upon later, the first step would be the provision, not of a motor gun-carriage, but of a tractor. The demands made upon anti-tank guns can, however, only be met by providing them with self-propelled carriages, and this has been done with the 75 mm. gun, and also with a howitzer on agricultural tractor T35. Very little alteration was required either to the tractor or to the howitzer-carriage. For medium artillery mechanization is certain, and a tractor most likely, but the Ordnance Dept. is producing a motor gun-carriage, known as Mark X. The same applies to the heavy artillery, except that the carriage known as Mark IX and taking the 6-in. gun or 8-in. howitzer has passed its trials.

5.—Armoured Cars.

This subject has only been taken up recently, and it is intended to design an armoured car to accompany the cavalry reconnaissance.—(*To be continued.*)

Neck Collars v. Breast Collars. Lt.-Col. Müller shows how the neck collar of peace was, during war, at the request of the mounted troops, ousted by the breast collar. The higher commands all asked for breast harness for its ease of fitting, suitability to different sizes and types of horse, and, indeed, to the same horse in different conditions. The advantages of the neck collar, viz., larger bearing surface and better direction of pull, were outweighed by these, and by the further great consideration of suitability for mass production.

The Leipsic Lorry Exhibition, March, 1928. One of Dr. Stadie's careful articles based upon thorough statistical investigations, and with photographs, tables and graphs. Of the 38 firms exhibiting, 5 only are foreign (Citroën, Renault, Ford, General Motors and Steyr), so it would not be fair to draw any conclusions from these, and the exhibition must be looked upon as entirely a German one.

Nearly half the exhibits consists of omnibuses, special vehicles (fire brigade, conservancy, tip-wagons, etc.), and transport tri-cars. The remaining 59 exhibits are lorries, classified as follows: up to 1·5 tons, 19; 1·5 to 2·5 tons, 8; 2·5 to 3·5 tons, 15; over 3·5 tons, 17. As opposed to ideas abroad, heavy lorries are still much preferred in Germany, but

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these figures seem to show that even there the light lorry is increasing in favour.

Dr. Stadie says that in future we must distinguish fundamentally between light lorries up to 2 tons useful load, ordinary lorries, and omnibuses (which have now entirely separated themselves from the lorry class). The light lorries incline strongly to be built of car components, and this tendency is noticeable also in the next category, up to 2·5 tons.

Taking pre-War prices as 100%, the following changes in price have taken place in Germany during the last four years: cars, 125% to 66%; lorries, 100% to 66%. That such a reduction should be possible, can only be explained by the broader basis of production.—(*To be continued.*)

England's Equipment Industry in the World War, by Lt.-Gen. Schwarte. Notes on Winston Churchill's *The World Crisis*, in which the author, while pointing out the sharp contrast between England's position and Germany's in regard to providing the munitions of war, is still able to draw interesting comparison of common difficulties in industrial troubles, help to allies, etc. Amongst many matters in which his praise is not stinted, Gen. Schwarte can "only acknowledge with admiration" the task of equipping the American Army. Finally, he is too shrewd to fail to understand Churchill's apostrophizing, "Truly, O Germans, you have done enough for history," and adds thereto, "also it is to be hoped for the right to a better future for the living!"

Recent Meteorological Instruments and Methods. The practical Meteorological Service of Germany is in the hands of four different departments, each of which has affected instruments and methods. They are: the Storm-Warning Service of the German Marine Observatory (1876); the North German Public Weather Service Organization of the Prussian Ministry of Agriculture (1906); the Air Travel Warning Service of Lindenberg Observatory (1911); and the Army Meteorological Service (1913).

Among the recent methods and instruments due to the foregoing are: a distant wind measuring establishment alongside the artillery range at Kummersdorf, with measuring stations at 3, 6 and 9 kilometres distance; a wind gauge on telescopic mast, for use in wooded country; a light anemothermograph for use with small kites, registering wind and temperature up to 500 metres; a kite-balloon, which having certain flying properties, bridges the gap hitherto existing between the measurements recorded by registering balloons and those recorded by kites; an improved theodolite for measurement of wind at night, with a special lighting arrangement for reading the scales; and a rocket meteorograph.

Air Service, Berlin-Teheran. Berlin to Baku, daily, except Sundays, leave 11 p.m.; first night, Moscow; second night, Armavir; arrive Baku, 2.15 p.m. Leave Baku 6 a.m. Tuesdays; arrive Teheran, 12 noon. Leave Teheran on Tuesdays and Sundays by Junkers or Ukrvosduchputj aeroplanes week and week about.

(*September*, 1928.)—*Motorization Questions in Foreign Armies.* Compiled from Major Martel's article in the *R.E. Journal* for December, 1927.

The Leipsic Lorry Exhibition, March, 1928 (*continued*). Besides what was said last month about the increasing use of car components in light lorry construction, the following are the chief conclusions drawn:

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The arrival of the fast six-wheeler of 3 to 4 tons useful load continues the line of development started in the light lorries. The six-wheeler far surpasses all former lorries in adaptability to the ground, speed, and lightness in proportion to useful load, so that these, as well as economic advantages, favour its introduction. The adoption of pneumatic tyres and of the 6-cylinder engine continue to make headway. The percentage of six cylinders at the Exhibition has risen in one year from 21 to 50.

The use of Z.F. Standard gears has also much increased.

Gears which are very promising and should be watched are the supergears of Maybach and the N.A.G. plate-coupled magnetically actuated. The latter take 40 watts at 12 volts, but require no more than a button to be pressed, which can be done with one finger while the hand remains on the wheel.

Four-wheel brakes are now universal, since with large and fast lorries it is no longer possible to brake adequately with hand- or foot-brakes. The question of the auxiliary (mechanical, air-pressure, suction or hydraulic) is not yet decided.

The English practice of rear axle drive by worm-wheel continues to be adopted: its further introduction is to be reckoned with.

The use of home fuel as hitherto, rests with the Diesel engine, which has already gained ground.

The day of the slow, heavy lorry (10 to 12 m.p.h.) is over.

Photographs are shown of:

Mannesmann-Mulag 6-wheeler for 3-ton useful load.
Krupp 6-wheeler for 4-ton useful load.
Daimler-Benz 6-cylinder engine, 70 h.p.
Junker 2-cylinder Diesel engine for lorries.
Sectional model of Junker compressorless double-piston Diesel engine (the two pistons in each cylinder move in opposite directions, the one near the crank-shaft having a short connecting-rod and moving as usual, while the other, further from the crank-shaft, has two long connecting-rods and is reversed, *i.e.*, works towards the crank-shaft).
Dürkopp 6-cylinder engine.
The same—a valve in its cage being changed.

A diagram shows the lockhead brake, which introduces the hydraulic brake for lorries. The foot-lever works a piston, which actuates the pistons in the brakes by means of the pressure conveyed through pipes containing an acid-free mixture of castor-oil and alcohol, which is insensitive to temperature changes up to 100°F.—(*To be continued.*)

F.A.I.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*November–December*, 1928.)—*The Last War of Austro-Hungary.* Apart from the pathos of its title, with its reminder that the Austro-Hungarian Empire no longer exists, the Austrian Official History of the Great War will be a model if it observes the lines here laid down for it

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by the Keeper of the State Archives, Glaise-Horstenau. After dictating the general lines of the work the writer treats of tone. The history must keep itself apart from any party position whatsoever; no easy task when the sudden collapse of an army standing everywhere on enemy soil has to be explained. In order to remain non-political, it must be strictly objectively written, establishing events reliably and reproducing them with fidelity, leaving judgments to the reader. It must give a clear and true picture, embellishing nothing, and concealing nothing of importance. It would miss its object as a scientific work, were it conceived as a patriotic work of edification. The jingo spirit must be kept remote, and the history must serve truth and military science, even at the cost of prestige.

The Course and Collapse of the German Offensive of 1918 *in France*, by Capt. Ritter, late of the German General Staff. The story is very shortly told (only 13 pages, including 5 sketches), very clearly told, and thrilling in its simplicity throughout. It has no space for adjectives or hot air.

The idea of the offensive was born on the 11th November, 1917, a date which might well have contained in it the seeds of misfortune. As a result of a conference held on that day between General Ludendorff and the Chiefs of the General Staff of the two Army Groups of the Crown Prince Rupprecht and of the German Crown Prince, a protocol was drawn up, containing the following: "Our whole position demands that we should strike as early as possible, the end of February or beginning of March, before the Americans can throw large numbers into the scale. *We must beat the English.*"

The first proposal in order to give expression to this was an offensive both sides of Armentières, general direction, Hazebrouck. This, at any rate, as the *first* act of the coming offensive, was turned down, as, owing to the waterlogged condition of Flanders, April would have been the earliest date possible. The next proposal was to attack from St. Quentin, advancing to the line of the Somme, between Ham and Péronne, then with the left flank on the river to turn N.W. and roll up the English line. This plan, too, was dropped. A memorandum was then issued by G.S. Operations at German G.H.Q., which was opposed to any *single* great attack as likely to fail through the line bending back before it, and enemy reinforcements coming in on both flanks of the advance. The memo proceeded: "The whole offensive falls into two acts, an attack on a broad front, Cambrai–St. Quentin, and, about 14 days later, an attack, general direction, Hazebrouck."

Preparations were started accordingly on these lines, but a very curious change took place. Owing to increasing confidence, there came about almost by imperceptible degrees a fundamental change. The idea of two attacks, the first preparatory, the second decisive, was gradually dropped in favour of one great break-through, from which a rolling-up operation was to proceed. The St. Quentin attack (known as Michael), instead of being the first act, creating favourable conditions for the second, the Hazebrouck attack, which was to bring the decision, became the sole source of victory, in fact, exactly what the G.S. Memo had said a single break-through could not hope to be.

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The question then arose from this new state of affairs, of what nature was to be the development of a successful offensive at St. Quentin. As long as Michael was to be only a preparation for another attack elsewhere, the chief demand upon this attack, in accordance with the protocol, was for it to do the British Army the greatest possible damage. Hence, it would have to be applied where it promised the greatest *tactical* success, strategy taking for the time a secondary place. This promise was to be found on the German left, where reconnaissance had shown that the least resistance would be found. The 63 divisions for the attack were accordingly allotted to the 3 German armies concerned, from north to south, as follows: 19, 20 and 24.

Now that Michael had changed from being a preliminary operation, destined to stop on the Somme, to being the only attack, it became evident that the centre of gravity had shifted from the German left wing to the German right wing, since it was the right wing, which, the Somme having been once reached, would have to lead in the further development, viz., in the task of rolling-up the British front from south to north. Strategy had now come into the picture, and the claims of tactics and of strategy stood in sharp conflict.

Nor was a solution easy to find, since the transfer of a dozen or so divisions from the left wing to the right wing, on a front of 50 miles, would be a manœuvre necessitating a halt in the operations and allowing the enemy the time to go over to the strategic offensive. Two alternatives presented themselves. Either a re-grouping of the divisions, weakening the left in favour of the right, or the whole attack must be given a fresh object, which should suit the armies as they stood, with the preponderance of strength on the left. G.H.Q. could not agree to the first plan, owing to their determination "to break through somewhere," and the best chances for this lay on the left wing. They therefore agreed to the attack being pushed beyond the Somme, and a defensive front being formed against a possible French counter-attack from the south-west.

On the 23rd March, two days after Michael started, this extension of the original plan had swollen into a new double operation, viz., an advance on both sides of the Somme to separate the French and English, and an offensive against the French towards the line Amiens–Montdidier–Noyon.

These should, in the opinion of the author, not have been undertaken except against a badly-shaken enemy, whereas the experiences of the German right and centre armies showed that certainly powerful resistance on the part of the British was still to be reckoned with. In fact, the Germans were heading straight for the position of deadlock, which their own G.S. had foretold as certain to result from a single break-through.

The German successes of the 24th and 25th March caused their G.H.Q. to order a still greater extension of the objectives. The fronts of the three German armies flowed outwards like a fan, until the extension of their frontage brought about so great a reduction in depth, that the French reserves hurrying up were able to hold them.

The strategic result of Michael was, first and foremost, that it had not

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brought the great decision. It had, however, severely damaged the British Army. Against this, the extension of its operations beyond the line originally intended had so far weakened the German Army, as to leave a quite insufficient number of divisions for an attack on Hazebrouck, should that idea be resumed. As a result of the deadlock existing, the Hazebrouck idea was revived, but the scale of its execution was too small (only 22 divisions taking part at first, and 36 in all, compared with Michael's totals of 63 divisions at first, and 92 in all), for it to have any real chance of success; and the second break-through also fought itself to a standstill.

With both attacks unable to progress and no strategical decision reached, German G.H.Q. was faced with the difficult task of discovering a new way of carrying out their intention which remained as before, "we must beat the English."

The plan chosen was to attack between Scarpe and Somme, against the line St. Pol–Abbeville, and at the same time on both sides of Lens towards St. Pol, thus pinching out Arras. On the 15th May, it was decided that there were not sufficient troops for this operation. Before such a stroke could succeed with the forces available, it would be necessary to draw off the reserves by attacking elsewhere first. A break-through for this purpose was, therefore, arranged and carried out against the French from the Chemin des Dames to the Marne. Its real aim of drawing off the British reserves from the intended next point of attack in Flanders was completely successful. But it provided the German front with one more bulge, and consequent increase of front, and it necessitated further attacks for the improvement of the front and securing it against being outflanked.

The most important of these took place on July 15th at Rheims. It was foreseen by the French, who reduced the defenders to a minimum, in order to carry out a counter-stroke. This took place on July 18th, on both sides of Villers–Cotterêt in the direction of Soissons–Laon, "and here we find the same interesting phenomenon which had already shown itself at the end of the Marne battle in 1914, that being forced to allow the strategic initiative to pass into the enemy's hands (provided one has insufficient strategic reserves immediately capable of re-seizing the initiative by attacking) leads irresistibly to the final loss of that initiative."

"On the 18th July, 1918, German G.H.Q. lost the strategic initiative irrevocably, exactly as they had done on the 10th September, 1914. The hopes of finishing the War by a victorious offensive had to be finally buried."

F.A.I.

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CORRESPONDENCE,

WIRE-NETTING ROADS.

The Editor, *The Royal Engineers Journal.*

SIR,

The recent correspondence in *The Royal Engineers Journal* about the origin of the wire-netting roads laid in the Sinai Desert during the Great War prompted me to mention these roads to a gentleman who had served in the Egyptian Public Works Department.

He stated that, before the War, wire-netting had frequently been laid on sandy ground in order to enable the motor cars of the Department to traverse country where camels were the only other means of transport, and that this method had been employed as long ago as 1910.

It would be interesting to know if the experience of the Egyptian P.W.D. was the real inspiration to our military engineers, and if not, to reflect how much valuable information may be lost by inadequate co-operation with civil departments, some of the main sources of Engineer Intelligence.

I am, etc.,
J. V. DAVIDSON-HOUSTON, *Lieut., R.E.*

"HANDBOOK ON TIDES."

The Editor, *The Royal Engineers Journal.*

SIR,

Referring to Professor Proudman's review of my *Handbook on Tides* in *The R.E. Journal*, September, 1927, and my letter in reply thereto, I would be greatly obliged if you would kindly allow me to supplement the latter. The learned Professor complained that I had not allowed for inertia, the effect of which " is by no means negligible," but did not challenge my definition of a perfect fluid, which is one that would offer no resistance to change of shape.

Differing from all previous writers, Mosely contended that tidal force cannot produce current, but only deformation of the spheroid by differential pressure and that the tidal wave is due to the transference of differential pressure to keep pace with the moon. If water was a perfect fluid this continuous *change of shape* would be effected without the interference of inertia. Water differs so little from a perfect fluid that the effect of inertia is very slight, as that mute but powerful witness *Nature* proves by placing high water at full and change as nearly as possible under the moon at Tristan D'Acunha, Kerguelen and the south point of Stewart Island, N.Z. (*see* p. 49 of *Handbook*).

In the currents of all previous theorists where the movement is one of translation, inertia would, of course, play an important part.

Yours faithfully,
J. F. RUTHVEN.

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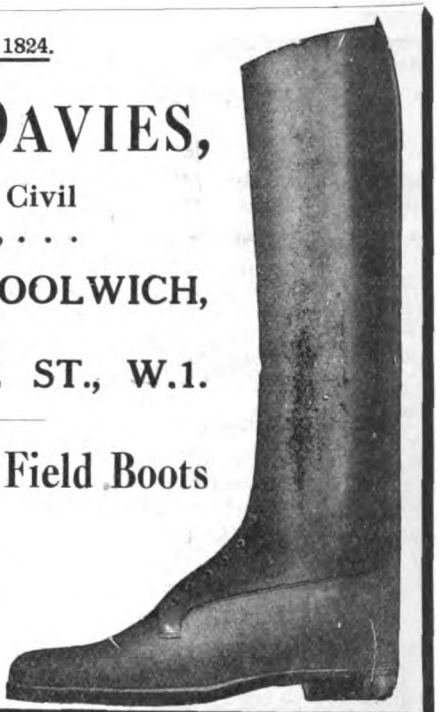

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ATTENTION is invited to the conditions under which this prize, in value about £14, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. It has been decided that the Prize shall be confined to Officers on the Active List not above the rank of substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions.—

(*a*) Descriptions of works actually carried out in peace or war.
(*b*) Invention.
(*c*) Design (excluding works of defence).
(*d*) Labour organization on work.
(*e*) Scientific investigations generally.
(*f*) Accounts of exploration work and surveys.

THE COOPER'S HILL WAR MEMORIAL PRIZE ESSAY, 1929.

THE following subject has been selected for the above prize, which is the third of the triennial prizes presented to the Corps by the Cooper's Hill Memorial Fund:—

"The Bridge Problem of the British Army."

Essays must reach the office of the Secretary, Institution of Royal Engineers, Chatham, not later than the forenoon of the 2nd September, 1929. Essays must not be signed, but each must bear a pseudonym and the name of the writer enclosed in a sealed envelope must be attached.

The Cooper's Hill Memorial Prize is a bronze medal, a parchment certificate, and a sum of money, about £20.

(*a*) Qualifications of the Competitors.—To be a regular officer of the Royal Engineers under the age of 35 on the 1st January of the year in which the award is made.

THE ARTHUR FFOLLIOTT GARRETT PRIZE ESSAY.

THE Council of the Institution of Royal Engineers has decided to award the Arthur ffolliott Garrett Prize to the best article, received and published in the *Royal Engineers Journal* in any year, which deals with any of the following subjects:—

1. Irrigation and Water Supply. 2. Railways. 3. Survey.

This will be retrospective for 1928. The notice in the January, 1929, *Supplement*, concerning the Arthur ffolliott Garrett Prize is therefore cancelled, and no special setting for an essay is to be considered as given for 1929.

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Will any officers who have had experience of any of these and can supply useful information, or are prepared to criticize such notes as are available, get into touch with the Officer i/c Training Manuals Revision, Room 037, War Office, Whitehall, London, S.W.1.

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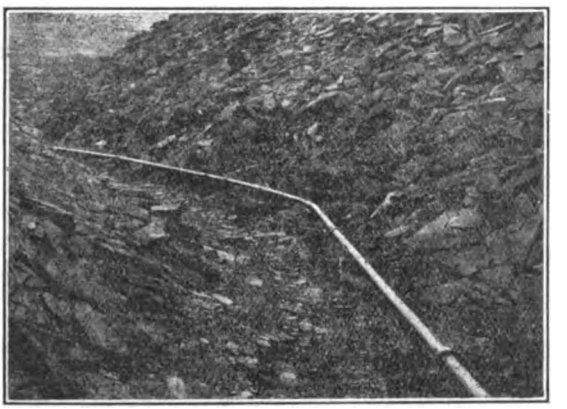

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HOW BRITISH COLONIES ARE GOVERNED.

A Lecture delivered at the S.M.E., Chatham, on February 14th, 1929, by BRIG.-GEN. SIR SAMUEL H. WILSON, G.C.M.G., K.C.B., K.B.E.

ONE often meets people who, in talking of our Empire, are prone, and perhaps it is understandable, to connect the name with the great self-governing Dominions, and to forget our numerous Colonies, protectorates and mandated territories which, scattered all over the face of the globe, form our Colonial Empire, with all its potential markets for British trade. I don't think, therefore, that at the beginning of a paper entitled " How our Colonies are governed " it will be amiss if I explain briefly what the term ' British Empire ' means, and how that Empire has come somewhat haphazardly into existence. I will then, if you will allow me, deal with the responsibilities with which the Secretary of State for the Colonies is charged and indicate how, in carrying out these responsibilities from London, he is assisted by the Colonial Office and its subsidiary organizations.

I will then explain to you the various types of constitution that are to be met with in the different non-self-governing territories, and the tendency that there has been of late years to meet the demand for responsible government, a demand which since the War has been pretty general all over the world.

The first recorded act of the British Government with a view to colonial enterprise dates back to the middle of the sixteenth century, when a Charter was granted by Queen Elizabeth to Sir Humphrey Gilbert, of Compton, Devonshire. The letters patent were dated June 11th, 1578, and I had intended reading them to you ; but I am not going to do so, as I find that legal documents were almost as ambiguous and boring 300 years ago as they are to-day. I will merely tell you that the letters patent gave to Sir Humphrey Gilbert the right to do practically anything he liked in any remote or barbarous lands which he might find unoccupied by any Christian prince or people, so long as he paid to the British Crown one-fifth part of the gold and silver ore he found therein. I must confess that in these days of democratic government and unofficial majorities, as an ex-Governor it makes my mouth water when I think of the power given to Sir Humphrey Gilbert.

No colony was ever founded by Sir Humphrey, as, although he took formal possession of Newfoundland in the name of his sovereign, the right was not practically asserted during her reign. Sir Walter Raleigh's two attempts in 1584 and 1587 to establish a colony in

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Virginia under the same royal sanction were as unsuccessful as had been that of his half-brother, and when James I. succeeded to the throne in 1603 there was not a single Englishman settled in America.

With the seventeenth century British colonization began in earnest. In 1605, a party of adventurers planted a cross somewhere in Barbadoes with the inscription, "James, King of England and of this Island," and in the following year charters were granted by the same monarch to the two companies which colonized Virginia and New England. In 1620, the first Colonial Representative Assembly was convened in the Bermudas; and in 1631, the first British settlement in West Africa was established on James Island, in the Gambia. I visited this island in October last during a tour I made on the West Coast. The remains of the old fort and the guns mounted therein, with which we controlled the trade of the Gambia, have recently been excavated.

The eighteenth century saw many important additions to the Empire in North America, the West Indies and West Africa. It also saw the disruption of the political structure of what is sometimes called the first British Empire, when the American Colonies declared their independence. Again, it was in the eighteenth century that the laying of the foundation of a new British Empire on true and enduring lines began. Canada played a great part in laying these foundations, a part which was eloquently described in a lecture delivered by Mr. Vincent Massey, the Minister of Canada to the United States. He began his sketch in 1759. In that year, he said, a great Englishman, Wolfe, met in battle a great Frenchman, Montcalm, in the fields near Quebec, and in a short and gallant fight replaced the lilies of France with the Union Jack of Britain. This battle between French and English was fought with the chivalry of a gentlemen's duel. Whenever you visit Quebec, if you look for the monument of Wolfe and Montcalm, you will find inscribed on its base one of the most stirring and fitting inscriptions ever chiselled in stone: "Valour gave them a common death, history a common fame, posterity a common monument."

In those days the conqueror, as a rule, was none too nice in his care for the feelings of the conquered, but wisdom and justice prevailed in the counsels of the time, and to the sixty thousand French people living in Canada were granted those precious possessions, liberty of worship and freedom of language. Thus was promise given of just treatment in Canada for this old community under their new flag.

After the peace of 1783, many thousands of people moved from the new Republic into British North America, and the year 1791 was the beginning of a new era in Canada. Upper Canada (now Ontario) was established as one province with a few thousand English-speaking settlers, and Lower Canada (now Quebec) was set up as another province on the banks of the St. Lawrence with a larger population,

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chiefly French. Each had its Assembly; each had its Governor; and each its nominated Chamber or Legislative Council. The grant of representative institutions to French and English alike was vastly important to the future of the Empire. It showed that British liberty and British rights were not to be enjoyed by inhabitants of Great Britain and their descendants alone, but were to belong to all those who lived under the Union Jack and were equal to the responsibilities involved.

The subsequent growth of responsible Government in Canada was important not only to British North America, but to the whole British Empire. It showed that responsible colonial government could be harmonized with membership in a great Commonwealth, and that as self-government grew, the attachment of the colony to the larger unit was not weakened, but rather strengthened. It was found possible, as Mr. Massey said in the address to which I have referred, to reconcile nationality and Imperial unity, despite all the melancholy prophecies of those who thought it could not be done, and as it became increasingly successful other self-governing communities in Australia, and in New Zealand, grew up within the Empire.

I have mentioned these points in connection with the growth of the first of our Great Dominions in order to emphasize the fact that it is the justice, freedom and fair play which are always to be found where the Union Jack flies, that have made it possible for the British race in the years that have passed since 1783 to build up an Empire such as the world has never seen before.

Just as the Dominion of Canada grew from the seeds sown at the end of the eighteenth century, so during the nineteenth century and the early part of the twentieth century, did the world see not only the birth of other self-governing Dominions, which now form part of the great British Commonwealth, but also the addition to the Colonial Empire of new colonies and protectorates all over the face of the globe.

It is of interest to pause here for a moment to take the measure of our Imperial responsibilities at the middle of the nineteenth century, as compared with those of to-day—in other words, the growth of a lifetime.

During this period little or no change has taken place in America and the West Indies, except that the vast areas in the Antarctic which are now valuable dependencies of the Falkland Isles were seventy years ago in more or less undisputed possession of whales and penguins. In Australasia, Fiji and numerous other islands in the Pacific have been added to the territories of the throne. In Asia—apart from mandated territories which were the result of the War—many native States in the Malay Peninsula and Borneo have come under the protection of His Majesty. In Europe and the Mediterranean, Cyprus has come into the picture. It is, however, in Africa that the most striking changes have occurred. I need only mention the

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addition of the Rhodesias, Nigeria, the Gold Coast, and the territories of East Africa, now known as Kenya, Uganda, Zanzibar, Somaliland and Nyasaland, together with the mandated territory of Tanganyika, to give you some idea of what the "Burden of Empire" means to-day. From the sketch I have given you so far you will have realized already that the development of the various systems of colonial government followed no pre-arranged plan, and even an epoch-making event such as the summoning of the first Colonial Conference, less than fifty years ago, was but a minor feature of the celebration of the 1887 Jubilee.

In Queen Victoria's speech on the prorogation of Parliament in 1886 reference was made to Her Majesty's Colonial and Indian possessions in the following terms:—

"I have observed with much satisfaction the interest which in an increasing degree is evinced by the people of this country in the welfare of their colonial and Indian fellow subjects; and I am led to the conviction that there is on all sides a growing desire to draw closer in every practicable way the bonds which unite the various portions of the Empire. I have authorized communication to be entered into with the principal colonial governments with a view to the fuller consideration of matters of common interest."

In conveying this invitation, Mr. Edward Stanhope, the then Secretary of State for the Colonies, closed his dispatch with the prescient words:—

"I am confident that your Government will, as I do, feel deep interest in this first attempt to bring all parts of Her Majesty's Empire into joint deliberation. However modest the commencement may be, results may grow out of it affecting, to a degree which it is at present difficult to appreciate, the interests of the Empire and of the civilized world."

You will observe that it is less than fifty years ago that the oversea governments were asked to join in a round-table conference. Conference succeeded conference at irregular intervals until the Imperial Conference of 1926, with its momentous definition of the position and mutual relation of the group of self-governing communities composed of Great Britain and the Dominions as autonomous communities within the British Empire. This decision provided for their being equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations. A year previous to this conference, it was realized that with the growth of autonomy in the self-governing Dominions the time had come to create a separate Department of State to deal with questions affecting the Dominions; and the old Dominions Division of the Colonial Office became, just over four years ago, the present Dominions Office.

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Here we may conveniently stop considering the evolution of government in the Empire as a whole and turn more particularly to those vast territories which come within the sphere of the Colonial Office. I mean the non-self-governing colonies, protectorates and mandated territories.

The immense importance of this undeveloped estate—as Mr. Joseph Chamberlain once called it—will be readily understood when I remind you that it comprises over two million square miles with a population of 50 million people, and with a trade already exceeding £500,000,000 a year. A trade which is doubling itself every few years and is capable of even still more rapid expansion.

To give you some idea of how that trade is developing I need only say that between 1905 and 1925, a period of 20 years, the value of the imports into the United Kingdom from the Colonies increased from under £20,000,000 to over £80,000,000. The value of the exports of British goods to the colonies increased in the same period from about £18,000,000 to just over £60,000,000.

In the year 1925, the total imports into the United Kingdom from the non-self-governing colonies were greater than those from the whole of India, or from any one of the self-governing Dominions. They were also greater than those from any foreign country, with the exception of the United States of America.

In the same year, the exports to the non-self-governing colonies were greater than those to any single country in the world except India, and in this connection it is interesting to note that in the period between 1905 and 1925 while the exports to India doubled, those to the non-self-governing colonies more than trebled.

Having given you these statistics in order to show the economic importance of our non-self-governing colonies, I will now give you some idea of the diversity of the problems with which the Secretary of State, assisted by the Colonial Office, has to deal.

The Secretary of State is responsible for the general control of policy, and in carrying out his obligations he has to communicate on a variety of subjects with no less than thirty-seven different overseas governments, each entirely separate from the rest, each administratively, financially and legislatively self-contained ; and all in different stages of development, with varying types of constitution, with varying rates of salary for civil servants, with varying climates and with populations composed of all kinds of races. The Secretary of State has, broadly speaking, no executive authority within the territorial limits of a colony or protectorate. His powers are exercised through the Governor, with whom alone he corresponds, and to whom alone he issues his directions. Although the Secretary of State selects for appointment the chief colonial officials, their actual appointment is made by the Governor, or High Commissioner as the case may be, who receives from the King a personal commission, and is the single

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and supreme authority responsible to and representative of His Majesty.

In addition to his personal commission, the powers which the Governor, or High Commissioner, exercises are derived from the instruments called the 'letters patent' and 'instructions.'

The 'letters patent' are more or less the same in all cases; they empower the Governor to appoint Executive and Legislative Councils, and they command him to do everything that belongs to his office according to his instructions to the laws of the colony, and amongst other things to any orders given by the Crown through the Secretary of State. The "instructions" go into more detail according to the circumstances of the different colonies, and lay down such matters as the composition of the Executive Council and in some cases of the Legislative Council, and so on.

You will observe, therefore, that the Secretary of State derives his power to control the actions of the Governor through that part of the 'letters patent' which command the Governor or High Commissioner to do everything that he may be ordered to do by the Crown through the Secretary of State.

In fulfilling his obligations, the Secretary of State is assisted by the Colonial Office and its subsidiary organizations. Every dispatch to a Governor or High Commissioner bears his name. He personally sees all dispatches which deal with important questions of policy, and no dispatch which disagrees with the views or recommendations of a Governor or High Commissioner leaves the Office without being seen by me, as Permanent Under Secretary of State.

Any sketch of the Colonial Office machine would be imperfect which did not include the subsidiary organizations through which, or with the aid of which, part of its work is performed.

The Crown Agents under the general supervision of the Secretary of State act as agents in the United Kingdom for all the non-self-governing oversea Governments. They purchase stores and raise loans for those governments, and carry out on their behalf all purely business transactions. The experience of the Crown Agents in the home markets, and their standardization of supplies, result in the Colonies gaining both in quality and price. The magnitude of the financial operations of the Crown Agents on behalf of the Colonies can be measured by the fact that loans amounting to £97,000,000 are now domiciled with and managed by them; and that they pay out annually in interest thereon the sum of £4,500,000, and are at the same time trustees for £18,500,000 worth of sinking funds for loan redemption. The Crown Agents purchase in each year on behalf of the Colonies just under £8,000,000 worth of stores alone. Amongst the many other duties they perform, they select on behalf of the Secretary of State candidates for engineering appointments; and again, one of the Crown Agents acts as "Director of Colonial Scholars," and helps

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in any way he can young men from the Colonies who have gained scholarships tenable in this country, and often arrive here for the most part friendless and with no one to turn to for advice or assistance —a job demanding tact and sympathy and an abiding recollection that once one was young oneself. The cost of the Crown Agents' Office is met by a small commission paid by the colonies, and in the case of the purchase of stores, it is only a fraction of that paid to any business agency for similar work.

The Colonial Audit Department, under the general control and direction of the Secretary of State, selects, trains and sends out local auditors to the Colonies, with whose accounts they deal. These auditors form a separate service, liable to transfer and with opportunities for promotion. You will readily understand the gap that this Department fills when I remind you that the proper audit of colonial accounts is as essential to good administration as is the proper management of the Colonies' finances themselves.

It is impossible in the time at my disposal to describe in detail the other subsidiary organizations of the Colonial Office, but these are 'The Tropical Diseases Bureau,' which collates and distributes information in connection with tropical diseases: the 'Colonial Advisory and Medical Sanitary Committee,' which advises the Secretary of State on medical and sanitary questions; 'The Advisory Committee on Education,' which as its name implies, advises the Secretary of State on all questions in connection with education as affecting our non-self-governing oversea territories; 'The Colonial Survey Committee,' which advises the Secretary of State on all matters in connection with the carrying out of colonial surveys and their rapid, economical and methodical prosecution; 'The Colonial Research Committee,' which administers a Parliamentary grant for the assistance of the smaller and poorer colonies in undertaking research work on matters of economic importance; 'The Oversea Defence Committee,' which is a Sub-Committee of the Committee of Imperial Defence, and advises on all questions in connection with the defence of the Colonies and Protectorates. It was as Secretary of this Committee from 1911 until the outbreak of war that I first came into touch with the Colonial Office and our Colonial Empire.

Another subsidiary organization which will shortly be added to the Colonial Office machine is a 'Colonial Agricultural Advisory Council,' whose duty it will be to advise the Secretary of State on all matters in connection with the development of agriculture in the Colonial Empire. The recent appointment of an Agricultural Advisor to the Secretary of State, coupled with the proposed appointment of an Advisory Committee, mark another stage in the development of our Colonial Empire, since the Colonies and Protectorates have agreed to pay annually into a common fund such sums as will be necessary to defray the cost of the new central organization.

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In addition, there are the Imperial Bureau of Entomology and the Imperial Bureau of Mycology, which exist for the purpose of encouraging and co-ordinating entomological and mycological work not only in the colonies but also in the Dominions and India.

There are other bodies which, although in no sense subsidiary to the Colonial Office, nevertheless afford it valuable assistance in its work, such as 'The Royal Botanical Gardens, Kew,' the 'London and Liverpool Schools of Tropical Medicine,' and 'The Overseas Nursing Association.'

The unofficial members of all the above organizations are men in the front rank of their respective professions, so that it will be seen that the Colonial Office and the Colonies obtain the best advice from persons acquainted with the latest developments of medical and other science in a way that it could not expect to do from any permanent technical staff appointed to perform similar duties.

Having now briefly described to you the administrative machinery which the Secretary of State has at his disposal in London, I propose to deal with the different types of constitution that are to be met with in the Colonies and Protectorates. Previous to doing this, however, it may be convenient if I explain very briefly the nomenclature used in describing the different kinds of territory. Those to which the term 'colony' is applied may broadly be divided into five classes. The first is the 'colony' in which there is no Legislative Council, and where the Governor is the legislature. The second is the 'colony' where the Legislative Council is nominated by the Crown. The third is the 'colony' where the Legislative Council is partly elected, but has an official majority.

These three classes of 'colony' are what used to be known as 'Crown Colonies,' a term which is purposely not now used owing to the wave of democracy that has been passing over the world since the War, and to the increasing demand on all sides for representative institutions.

The fourth class is the 'colony' in which the Legislative Council is partly elected and in which the unofficials are in a majority. The fifth class is the 'colony' with an elected House of Assembly and a nominated Legislative Council, or in other words, a Second Chamber.

In all but a few of the above, the Crown has reserved the power of legislating by Order in Council, as a survival of the theory that the sovereign governs his possessions beyond the seas by virtue of the royal prerogative. The Secretary of State thus has a weapon in reserve whereby, coupled with the power to advise the Sovereign to disallow any Bill of a Colonial Legislature, he can defeat measures passed by the latter, or enact a law that they have refused to pass. It is hardly necessary to add that nowadays recourse would very

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rarely be had to this weapon, and not at all unless important Imperial or local interests were involved, and then only after all efforts at persuasion had failed.

The term 'protectorate' is used to describe a territory which is really outside His Majesty's Dominions, but which has no political relations with foreign powers except through or by permission of His Majesty's Government. The inhabitants of such territories are not British subjects, but British protected persons.

Although in theory a 'protectorate' retains its internal sovereignty and the right to manage its internal affairs in its own way, most of the protectorates forming part of the British Empire have in actual practice and in course of time come to be in almost exactly the same position as colonies and are administered in the same way.

A 'mandated territory' is a territory in respect of which a mandate to administer the territory on behalf of the League of Nations was accepted from the principal allied and associated powers, and the power which accepted the mandate is under certain obligations to furnish information annually to the Council of the League. There is no provision in any of the mandates for their transfer or termination.

The actual degree of authority and control to be exercised by the mandatory power in each territory is defined in the document known as the 'mandate.'

Under what is called an 'A' mandate, the mandatory is placed in the position of an adviser rather than that of an administrator, except in the case of Palestine, where the High Commissioner actually administers the territory.

Under what is called a 'B' mandate, the mandatory is responsible for the administration, subject to certain guarantees as to the suppression of abuses and the maintenance of economic equality as between all States, which are members of the League. An example of this mandate is Tanganyika.

Under what is called a 'C' mandate, the mandatory is allowed to administer the territory as an integral part of its own territories subject only to certain provisions, which are more limited than those applying in the case of the 'B' mandate. The Secretary of State for the Colonies has no responsibility for any territories administered under a 'C' mandate."

It would be impossible in a short time to describe to you in any detail all the different types of constitution which, as you will have noticed from my description of the term 'colony,' may broadly be divided into those in which the Crown still has the control of legislation and those which possess representative institutions, but not responsible government, and in which the control of the Crown is limited to having a veto on legislation.

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In order to give you some idea quickly as to how the different legislatures vary, I don't think I can do better than take a few examples and describe to you briefly how the functions of government are carried out in each case.

The constitution of Kenya provides for an Executive Council composed of the Governor as President, seven officials as *ex-officio* members, and such other official or unofficial members as the Governor may appoint; and for a Legislative Council composed of the Governor, as President, eleven *ex-officio* members, not more than nine nominated official members, eleven European elected members, five Indian elected members, one Arab elected member, and one nominated unofficial member to represent the interests of the African community.

It will be seen, therefore, that the existing constitution provides for an official majority in the Legislative Council.

For some years past, there has been considerable controversy over the representation in the Council of the Indian community, and in point of fact Indian representation has been secured by nomination. The Indians have been persistent in their demand for a common electoral roll for all British subjects, and the European population of the colony has been equally persistent in opposing any suggestion that election to a Legislative Council should be on any other than a communal basis.

Again, during the last few years there has been an increasing demand on the part of the European settlers for a white unofficial majority in the Legislative Council. The whole question has just recently been dealt with in the Report of the Hilton Young Commission, which visited East Africa last spring with a view to reporting on the closer union of the British East African territories. The report of the Commission is now under consideration, and no decision has yet been reached.

Bermuda was given representative institutions in 1620 by the Bermuda Company of London, which agreed to the setting up of a 'General Assembly,' but the Charter of the Company was annulled in 1684; since then, the Governors have always been appointed by the Crown, and government has been effected by a Governor advised by an Executive Council, and a legislature composed of a Legislative Council and a House of Assembly.

The Executive Council, which is purely advisory, is composed of four official and three unofficial members; the Legislative Council is composed of three official and six unofficial members, and the House of Assembly is composed of thirty-six members, all elected.

It will be seen, therefore, that there is an unofficial majority in both houses, and that the Governor has no power to enact legislation which is in any way unpopular locally. The Crown has, of course, the power to veto legislation, but Bermuda is one of the five Colonies in

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the Colonial Empire where the Crown has not the power to legislate by Order in Council.

In the Gold Coast there is an Executive Council composed of five *ex-officio* official members with the Governor as President, and a Legislative Council composed of fifteen official members and fourteen unofficial members; so that it will be observed that there is an official majority. In 1925, the composition of the Legislative Council was altered to include for the first time elected members. Of the fourteen unofficial members, six are head chiefs elected as provincial members of the Council, three are municipal members elected to represent the towns of Accra, Sekondi and Cape Coast respectively, and there are five unofficial members, one representing commerce, one the mining industry, and three appointed by the Governor.

Ceylon is administered by a Governor, aided by Executive and Legislative Councils. The Executive Council is composed of three *ex-officio* members, and such other nominated members as the Governor may appoint, and the present Council consists of two nominated official members and four nominated unofficial members. The Legislative Council is composed of 49 members, made up of five *ex-officio* official members, seven nominated official members, three nominated unofficial members, and thirty-four elected unofficial members. Of the thirty-four elected members, eleven represent special interests and communities, and twenty-three represent territorial constituencies.

This is one of the comparatively few colonies in which the Governor does not preside over the Legislative Council.

The present constitution of Ceylon was settled by Orders in Council issued in 1923 and 1924, and by letters patent and instructions issued in 1920. It is a good example of a constitution where there is an unofficial majority in the Legislative Council, and where the Executive, *i.e.*, the Governor and his advisers, has responsibility without power.

Ceylon also provides a good example of how difficult it is to satisfy a community, which in these democratic days wants more and more power each year. Although it is less than five years since the present constitution came into existence, the Secretary of State thought it desirable in the summer of 1927 to appoint a Commission, under the chairmanship of Lord Donoughmore, to report on the working of the present constitution, and how, if at all, it should be amended. The Donoughmore Commission, after visiting Ceylon, reported in June last year, and in their desire to find some half-way house between a colonial constitution giving the Governor not only responsibility but also power, and a constitution which provides for full responsible government, have made recommendations for the setting up of a State Council and for appointing committees of this Council, each under the chairmanship of a Ceylonese Minister, to be responsible for

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the administration of the different government departments. No decision has yet been come to on these somewhat novel but ingenious proposals.

Malta stands by itself in the Colonial Empire as an example of the modern theory of "dyarchy"; the present constitution having been given to the colony in an attempt to reconcile Imperial interests with local aspirations, and to put an end to a long history of controversy with the home government. In nearly all matters of internal concern, Malta has enjoyed since 1921 responsible government, *i.e.*, its chief executive officers are "ministers" responsible to the local legislature, which comprises a Senate and a Legislative Assembly. In order to ensure that the Imperial Government has full responsibility for the safety of this important naval base, certain matters are what is called 'reserved' generally or specifically in the constitution.

The Governor, who is always a distinguished military officer, has two Councils to assist him. These are an ordinary Executive Council such as we find in a self-governing Dominion, composed of Ministers, which advises him on all the non-reserved matters; and, secondly, a nominated Council composed of the Lieutenant-Governor, the legal adviser, and three officers chosen from the garrison and representing the three combatant forces. The latter Council is in the position of the ordinary Executive Council of a colony in respect of the reserved matters.

The Senate consists of 17 members, ten of whom are either elected or nominated representatives of special interests, such as clergy, nobility, and Chamber of Commerce. The remaining seven, who are called the General Members of the Senate, are persons possessing some special qualification likely to make them useful members of an Upper Chamber, elected on a restricted franchise.

The Legislative Assembly consists of 32 members, all elected to represent the eight electoral districts into which the Maltese Islands are divided.

The Governor can, if he sees occasion, summon the two Councils to sit together as the "Privy Council of Malta." Power is reserved to the Crown to disallow any law, and the Governor can reserve any Bill for the signification of His Majesty's pleasure. The Crown, by Order in Council, or the Governor, subject to the King's approval, can legislate on the 'reserved matters.'

I cannot close my description of the different types of constitution without referring to Jamaica, a colony which a few years ago I had the honour to govern, and the constitution of which contains a unique provision.

In this colony there is a Privy Council presided over by the Governor, and consisting partly of official and partly of unofficial members nominated by the Governor.

The Legislative Council consists of the Governor, as President, five

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ex-officio official members, nominated members not to exceed ten in number, and fourteen elected members.

The unique feature of this constitution is that nine out of the fourteen elected members in a Council of twenty-nine can throw out any measure which involves expenditure, and that the unanimous vote of the whole fourteen elected members cannot be over-ridden by the other votes unless the Governor declares the matter to be of 'paramount importance' to the public interest.

You will observe from the description which I have just given you of some of the legislatures of to-day, that it has been no part of the policy of the British government to force either the executive or the legislative machinery of the colonies into a common mould.

I have referred to the striking changes that have taken place during the last fifty years in Africa; and I think that in the short time which is still at my disposal I must touch on the almost phenomenal way in which our African colonies have developed in the last few years, and also on the system called 'indirect rule' which is one of the most interesting features of the internal administration of these colonies. For this purpose, I cannot do better than take as an example one of the largest of our territories in tropical Africa—I mean Nigeria—the revenue, which in 1915 was not quite £3,000,000, rose to over £8,000,000 in 1925, figures which show you at once the rapidity with which trade and development went forward. When I travelled through Nigeria last August and September, in comfortable trains and motor cars, I could not help recalling the fact that less than thirty years ago those great territories were without roads and railways, and were peopled by tribes so uncivilized as to necessitate military operations from time to time, and it was borne home to me how wonderful it was that, in such a comparatively short time, this great country had been transformed by a handful of determined administrators and soldiers into the peaceful, law-abiding and rapidly developing territories that one sees to-day. When, however, one saw the young officer of the Colonial Service living in his bush hut, perhaps seventy miles away from a doctor or any other white man, and cheerfully carrying on the administration of a district as large as two or more English counties, one's wonder at the rapidity with which civilization has spread began to die away, and one realized more than ever how utterly wrong are those who are so fond of saying that the British race of to-day is not what it was. It is unnecessary, gentlemen, for me to remind you of the part played in the development of these and other colonies by officers of the Corps, for did not General Pritchard last year give you a lecture on this very question, and did not he remind you of the great work done by officers of the Corps in the development of our Colonial Empire, not only in the fields of engineering and survey, but also in administration.

I have referred to the system of 'indirect rule.' The retention of

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as much as possible of the original native form of government under the great tribal chiefs and emirates plays an important part in the internal administration of our African colonies.

These administrations are looked upon as an integral part of the British machinery of government. No alien form of government is imposed on the natives from without ; on the contrary, the authority of the chiefs is strengthened and they are encouraged to realize their responsibilities in the development of their territory and in the welfare and progress of their people. The native administrations are naturally closely supervised by British officials in the territories concerned, but only in an advisory way and in order to check and abolish customs and practices that are detrimental to the best interests of the people. When I visited Northern Nigeria in August last, the Emir of Kano showed me with great pride over his headquarter offices, his treasury, his Court of Justice, his police barracks, and his prison, all situated in the walled city, and I must confess that the efficiency of all I saw was most remarkable.

In concluding, I would like once again to remind you of the important part our Colonial Empire, if properly developed, is destined to play in the future of the British race ; and I would also like to remind you that in spite of the almost bewildering diversity of the questions constitutional, economic and cultural that arise, there exists nevertheless a large measure of unity. This is due to the fact that the Colonial Empire is almost wholly a tropical and sub-tropical Empire, and that in consequence the health and economic problems in its different parts are very similar, that it is an Empire of mixed, and in the main non-European and largely primitive populations, and that the ultimate responsibility for the general control of its affairs must for some time to come fall on His Majesty's Government.

Last, but not least, I would like to say that the unity that exists is due to a great extent to the community of ideals and purpose which animate the Colonial Service, the members of which never forget that it is their duty, no matter how trying the conditions under which they have to serve, to hand down to posterity, in, if possible, a better state than they found it, the great heritage that has been bequeathed to us by our forefathers.

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THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR, 1914–18.

(*Concluded.*)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART VI.—APRIL, 1918—MAY, 1919.

Battle Honours during the period—" Lys," " Bethune," " Arras 1918," *" Drocourt-Queant," " Hindenburg Line." " Epehy," " Beaurevoir," " Sambre."*

GIVENCHY, 1918.

ON the 11th April, the 1st Division had taken over the Cambrin sector from the 11th Division, and on the 15th and 16th took over the Festubert and Givenchy sectors from the 55th Division, whose historic defence of Givenchy during the German offensive of April 9th and following days is well known to fame.

The 23rd (Field) Company, R.E., arriving by road and rail, concentrated at Annezin on April 8th. On the 9th, 2nd-Lieut. Henderson joined for duty, and was posted to No. 4 Section, 2nd-Lieut. Pocock having taken over No. 3 Section. On the 10th, the Company moved to Sailly Labourse, two sections going to work in the line in the Cambrin sector. The following day, they moved back to Fouquieres, and on the 16th back, as the diary says, " along the same old road " to N. Annequin, a mining village now vacated by the " civiles " at last, leaving all their goods and chattels, their wine and beer and stores. Steps were taken for the security of these tempting goods.

That night, the sections worked on the Givenchy defences, which had suffered severely in the fighting of the previous week.

On the 18th, in the very early hours, the area was heavily gas shelled, but the company billets being just outside and upwind of the gassed area, they escaped. This gas shelling was a curious and unforgettable sound, a continuous whining as hundreds upon hundreds of shells, fired as rapidly as guns could be worked, streamed into a restricted area, bursting with quite a gentle popping noise reminiscent of more genial and peaceful occasions. However, this was invariably the prelude to some major effort on the part of the enemy, and the Company at once " stood by " in case of need, Brigade H.Q. being informed. At 11.30 a.m., orders (timed 8.30 a.m.) were received both from the C.R.E. and Brigade H.Q., to garrison the Le

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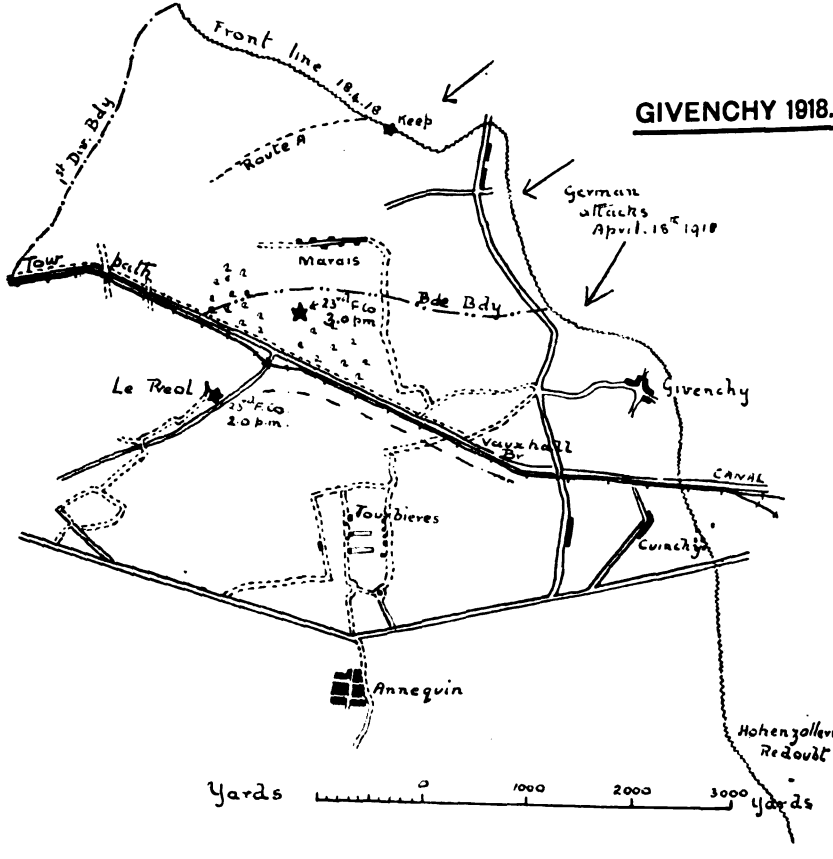
Preol locality. Le Preol was reached at 2.0 p.m., after a very rocky journey, " in record time, helped along by the enemy's shells." The keep was practically obliterated by 12-in. shells, and had the message reached the Company earlier, the sections would no doubt have been obliterated too. It was still being shelled, but Brigade H.Q. ordered the sections to move on and garrison Marais keep.

SKETCH No. 25.



The cyclist orderly, Sapper P. E. Dymond, who had brought the message to Company H.Q. from Brigade H.Q., having already gone from the Company to Brigade, arrived without bicycle and almost without clothing, for he had made his way through intense shell fire, had been slightly wounded by a gas shell which burst quite close to him, but nevertheless carried out his task most gallantly, his devotion to duty being rewarded with the Military Medal.

Hard fighting had been going on around Givenchy and Festubert, between which places the enemy had made some progress, and also along Route A, on the left flank. Eventually this attack was brought

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to a stop with very severe losses without any important loss of ground. As soon as it appeared that the situation was in hand, work was awaiting the Company, for a lucky double hit by 12-in. shells had caused serious gaps in the canal towpath, not only threatening with inundation the low-lying woods in which our supporting troops were ensconced, but also blocking the main line of evacuation of wounded from Givenchy. In the first place temporary bridges across the breaches in the towpath were made, to allow traffic to get along, and by dark a temporary dam in the canal bank had been constructed of boards and sandbags, a moderately effective work. The day had been an exhausting one, for, in addition to the constant shelling of the area, the strain always attendant on waiting in position, wondering when the battle is really coming one's own way, and the rapid work on the bank in the evening, gas masks had been worn for considerable periods, always a depressing and unpleasant performance. The Company had eight casualties, including three badly gas-blistered. Two sections, Nos. 2 and 4, went up to Givenchy to work on the repair of communication trenches.

On the 19th, work on the dam was continued, now more urgent than before as heavy snow had fallen, water level in the canal was rising, and the temporary dam was failing. Luckily there was a boat-builder's yard nearby with a plentiful supply of 12 in. x 2½ in. timber; a pile sheet dam was made, being completed by Nos. 1 and 4 Sections by 6.0 p.m. This was further strengthened the following day by the construction of a second dam behind the first, both puddled with sandbags and clay and the space filled with brick and clay, the roadway then being completed on top.

During the 19th, a successful counter-attack between Givenchy and Festubert had regained an important series of trenches and dugouts, and whilst Nos. 2 and 3 Sections were engaged in wiring the bridgehead positions covering Vauxhall and Westminster Bridges, No. 1 Section, having completed its work on the dam, moved up to Givenchy to repair fire trenches, firesteps and strutting of damaged dugouts, all the woodwork having suffered severely during the bombardments of these two days. Just at a moment when the work was well under way, heavy shelling commenced, and threw the sappers and their infantry working parties into some disorder, and very shortly after Germans began to appear, and it was evident that a counter-attack was taking place. Sapper Alfred Pratt, who was in charge of a mixed party of sappers and infantry, with great courage and resolution got together his scattered men and organized them on the firestep ready to beat off the attack, showing a fine example of courage, cheerfulness and leadership. For this he received the Military Medal. During the same bombardment a sapper and a German prisoner were buried in a dugout, but in spite of the shell fire, Corporal Vick, a fine N.C.O. who had been with the Company since 1915, assisted by two

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sappers, dug out these two men after two hours' hard work. Corporal Vick was awarded the Military Medal.

That evening, the C.R.E. received the following message from Division H.Q.: "The G.O.C. sends his hearty congratulations for their gallant work to all ranks engaged in this morning's operations." It had been a hard, nerve-racking day's work under battle conditions, and every man in the Company had pulled his weight in the finest manner.

On the 20th, in addition to those sections which were still at work on the dam in the canal bank, No. 4 Section built a barrel pier raft for carrying stores, the overland roads and tracks having been so severely damaged by shell fire. The raft took 18 men or a G.S. wagon fully loaded. In the evening, Nos. 1 and 3 Sections, somewhat delayed by an enemy barrage, moved up to the line to repair gaps in the trenches for the "Boche snipers were becoming a bit of a pest." This repair work was continued on the following nights.

A feature of the fighting at this time was the constant shelling of back areas and forward roads, putting a severe strain on the mounted section, which, however, true to its reputation, never failed to deliver the goods. On the night of the 23rd, the Company billets and horse lines were shelled, resulting in 14 casualties, including Pocock, Thomas and the farrier-serjeant, and seven horses hit. Emulating the example of Driver Bianchi, the Company's first D.C.M., Driver J. Wooldridge set a fine example of quiet coolness and courage to the other drivers, quieting the frightened horses and getting his own pair clear of the shelled area. After that, he came back and helped to bind and remove the wounded, finally fetching an ambulance. No Military Medal was better earned than his.

On the 22nd, Captain Carter had been transferred to the 233rd (Field) Company, and his place was taken by Captain W. G. Smith, M.C., from the 26th Company. As may be imagined, Smith received a warm welcome on returning to his old unit, for all ranks were glad to see this gallant officer back with them again.

On the 24th April, the 55th Division having taken over the defence of the Givenchy sector once more, the 1st Division side-slipped, and the 23rd (Field) Company once again found itself in its old pleasure resort, the Hohenzollern sector, where the War was continuing to take its even course of the last three years, undisturbed by great events to the north and south.

The work was the usual round of trench and dugout maintenance, construction of machine-gun posts, and, a new item, a tank trap at the point where the reserve line crossed the railway.

On May 2nd, Lieut. Dougill joined, and on May 3rd the award of the Croix de Guerre to Major Wilson was gazetted.

On the night of May 24th, Lieut. Cowley, reputed to be one of those queer individuals who thoroughly enjoyed a good shelling or a

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bloodthirsty scrap, took part with eleven N.C.O.s and sappers in a raid carried out by the K.R.R. As the party arrived at Battalion H.Q. a telephone message was received that the R.E. officer was not to go with the raiding party. " Damn," says Cowley, " I didn't hear that message." Just as the party was preparing to go over the top, a written order arrived. " Lieut. Cowley will not go with the raiding party, he will return forthwith." Putting this unwelcome missive in his pocket, Cowley shouted, " Come on No. 2," and off they went, Cowley, Lce.-Cpl. Obee and four sappers with the left party. Unfortunately, having got into the German second line, they were caught by our own barrage, and all but one sapper became casualties. The gallant Cowley died in hospital as the result of his wounds, to the great regret of all ranks.

The right sapper party consisted of Corporal Jones, Sappers Dymond, M.M., Woolcock, Braund, Dewey and Coleman. They, like Cowley's party, went over with the second wave of the infantry, and also ran into our own barrage, but withdrew until it lifted. They had started out with a Bangalore torpedo, but, finding the wire cut, dropped it, and went off in pairs to the dugouts to which they had previously been allotted. Woolcock and Dymond went to No. 1, which had two entrances, one in the support line and one in the communication trench. A German dashed out full of fight, and was faithfully dealt with by Woolcock with his bayonet, and two more who came out with the first surrendered. As voices were heard below a Mills bomb and a mobile charge were exploded down the dugout, and the two sappers made their way back with their prisoners and a wounded rifleman. Woolcock was slightly wounded.

Braund and Dewey arrived at No. 2 dugout just as a rifleman was bayoneting a German. Four more of the enemy were winkled out of the shell, and others foolishly remaining below received two more mobile charges.

Jones and Coleman disposed of their charges at No. 3 dugout without opposition.

Altogether the 23rd Company had a good night out, as evinced by the fact that 2nd-Corporal D. Jones and Sapper R. Woolcock both received the Military Medal for their gallantry.

In addition, the following letter was received by the O.C. from the G.O.C., 2nd Infantry Brigade.

" With reference to the raid carried out last night, I should like to express my great appreciation of the good and gallant work done by men of the 23rd (Field) Company, R.E., who accompanied the raiding party.

" Their presence contributed materially to the success of the enterprise, thanks to the skilful handling of their explosives, while their dash and courage in the advance to the objective was most marked.

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"In saying the above, I am expressing the opinion of the raiding infantry, and I trust my remarks may be conveyed to the men who took part in the raid. I much regret that the casualties, in proportion to the numbers who took part, should have been so unfortunately high.

(Signed) G. C. KELLY, *Brig.-Gen.*,
Commanding 2nd Infantry Brigade."

The Company shortly after moved to Tourbières, where, on the night of June 1st, occurred what might have been a most dangerous accident had it not been for the courage of three men, Corpl. H. Whitty, Sapper E. Mather, and an attached N.C.O. of the 1st Camerons, Lce.-Cpl. D. McDonald. The Company billets were heavily shelled, and a shell struck a tool cart, exploding the primers and detonators, setting fire to a large quantity of guncotton. The flames blazed up to the top of the barn, which was full of straw in which the cart was standing. Sapper Mather arrived on the scene first, and with the greatest gallantry commenced to pull out the burning guncotton. In this he was shortly assisted by Corporals McDonald and Whitty, and these three eventually put out the fire and saved the remaining 100 lb. of guncotton and 50 lb. of ammonal in the tool cart, in spite of the fact that shells were continuing to fall in the billet area. For their gallantry each of these three men deservedly received the Military Medal.

The Company remained in this area until the end of August, the only work of interest being the preparation of all bridges in the area for destruction in case of further successful attacks by the enemy.

2nd-Lieut. Gates joined the unit on June 3rd, and on July 21st Major W. R. Wilson, M.C., was appointed C.R.E., 40th Division. The command of the Company devolved on Captain W. G. Smith, M.C. The new O.C. was an officer young in years, but of unusual ability; although the Company records contain little mention of outstanding deeds (probably because for a long period he kept the diary himself), those officers and men who worked with him speak with pride and affection of a quiet, gallant gentleman doing his duty to the utmost, pushing his jobs through under all conditions of battle or weather, and setting a high standard of soldierly achievement. It is with deep regret that it must be recorded that he died in 1923 as a result of the hardships he had undergone during the War.

On August 22nd, the Company moved to Boyaval, and on the 31st received orders to move at short notice. The move took place at 5.0 p.m., and at 1.0 p.m. on September 1st it arrived at Arras, moving up to assembly positions in Guemappe. Tool carts and pack animals joined the dismounted sections that night. On the following day took place the splendid Canadian attack on the Drocourt-Queant line. The 1st Division was in support of the two Canadian Divisions, and

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was given the task of consolidating the line behind the Canadians, or alternatively, if the attack was more successful even than was expected, to go through and exploit the victory. However, the attack, though reaching all its objectives, did not break the enemy resistance to such an extent that the 1st Division could go through, and on the 2nd the 23rd (Field) Company was engaged in consolidating the captured trenches at Dury, Company H.Q. being at Strike Copse, on the Arras-Cambrai road.

On the 3rd, the Company (less one section) worked with the 1st Infantry Brigade on the forward road at Remy, the following days, during which the 1st Division was in the front line between Leclure and Recourt, also being taken up with road making. The night bombing was very severe at this time, and although the material damage was hardly commensurate with the effort, it was very disturbing to the night's rest.

On the 8th September, the 1st Division having been relieved by the 56th, the 23rd Company moved back to Arras and thence by train to Marcelcave in the 4th Army Area, arriving on the 11th.

On the 12th, the Division took over the front from the 32nd Division between Bois Holnon and Vermand (Sketch No. 26), whilst the infantry on the 13th were making ground by vigorous patrolling, the Company moved by bus to billets on the Deuie-Meraucourt road, two sections then proceeding to erect a trestle bridge next to the demolished bridge at Caulincourt Château. The following days were occupied by the Division in gaining ground in order to obtain a satisfactory jumping-off line for the attack of the 18th, the Company being mainly engaged on the improvements to roads in the forward area. The roads were in bad condition, traffic was very great, and it was found that the mounted orderly was of far greater value than the push cyclist in maintaining communication with the C.R.E., in fact, mounted orderlies during these operations were absolutely essential.

The attack was carried out on the morning of the 18th, 1st Infantry Brigade on the right. The Company (less transport) moved up to Leaf Wood. Lieut. Roberts and Lieut. Dougill taped out the forming-up areas for the troops, and one section accompanied the 1st Brigade in its attack, to assist in consolidating the ground gained. One section was still required to work on the Caulaincourt Bridge, and another on the bridge at Vermand. The attack was successful, the approximate line reached being shown on Sketch No. 26. During the 19th and 20th, one section continued work in the 1st Brigade Area, the remainder of the Company being fully employed on the five bridges between Vermand and Caulincourt.

On the night of the 21st-22nd, the 1st Division side-slipped by a front of one brigade to the right, with a view to carrying out an attack on the 24th. Preparatory to this attack, two sections constructed a brigade battle H.Q. Roberts and Henderson taped out

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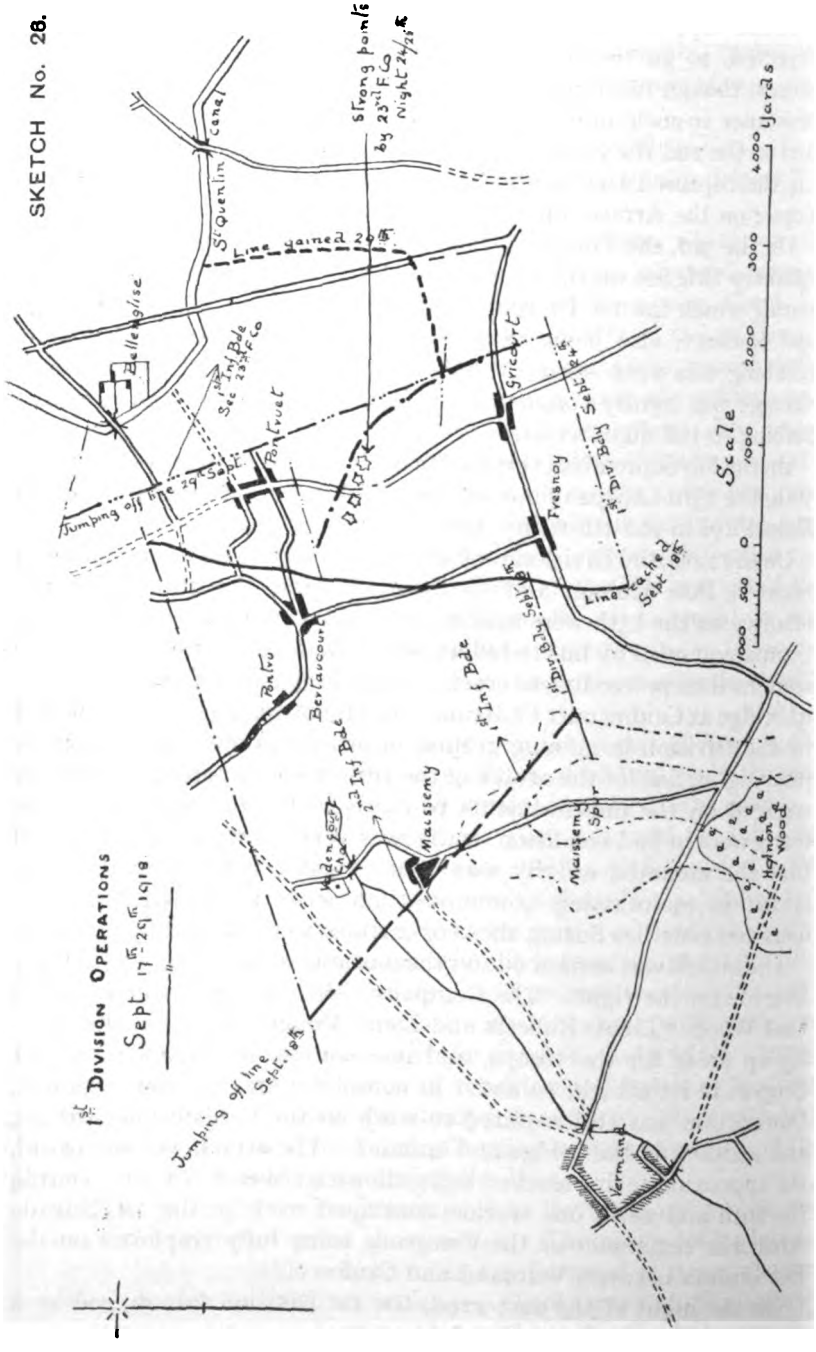

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the forming-up areas for the attack. The following method was adopted for this. The line was taped out during twilight with spun-yarn, the latter being replaced before assembly with tape, thus making it possible to test the lay-out during daylight.

The attack was very successful on the right, but on the left severe opposition was encountered about Pontruet, with the result that on this flank there was a bend back of the line. The whole Company was therefore utilized in the consolidation on the night of the 24th-25th, ten posts each to hold two sections being constructed between Pontruet and Gricourt. Work on these posts was continued on the 26th and 27th, but on the 28th the Division having now side-slipped by one Brigade to the left, the Company returned to work on the bridges.

One section was employed in removing an anti-tank minefield in the neighbourhood of Epehy, consisting of a long line of tank traps, 9 in. x 3 in. planks on 10-in. trench mortar shells, lightly covered with earth. The section had lifted the planks off for nearly a mile, when there was a sudden explosion, and Corporal Savage and Sapper Borthwick were blown to pieces. Both these men had been with the Company all through the War, and their loss was deeply felt. It was found that the traps were now arranged so as to go off whether the plank was pressed or raised, and after this accident a rope was placed round the planks and they were removed from a safe distance.

On the 29th took place the great attack on the Hindenberg line, the 1st Infantry Brigade being detailed to form a defensive flank on the canal, the main attack breaking through to the north of Bellenglise. The only part taken by the Company, however, was the construction of a tank track by one section.

On the 30th, the operations were continued, the 32nd Division north of the 1st Division swinging right-handed, the latter maintaining communication with the French on the right, who were not making any progress. One section of the 23rd (Field) Company accompanied the 3rd Infantry Brigade during this attack to assist in consolidation, the remainder of the Company being employed on advanced division H.Q. at Bertancourt, several casualties having been caused at H.Q. by shelling from a long-range gun.

On the 4th October, the 1st Division was withdrawn into Corps reserve, the Company billeting first in Marteville and then, like the remainder of the Division, in the old German dugouts of the Hindenberg line at Bellicourt.

In the orders of October 3rd, Serjt. W. N. Harris, Corporal B. Obee, Corporal W. Pilcher, Corporal J. Newnham, and Sapper J. Sewell were each awarded the Military Medal. All of these men had done consistently good work, and set a high example of courage during the previous year. Several had been recommended for special acts of gallantry on previous occasions, notably Harris and Sewell, who as far back as the battle of Loos had given fine examples of courage and

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devotion to duty, and again at Givenchy, Sewell being one of the sappers to assist Corporal Vick in digging out the buried men in a dugout under heavy shell fire.

As the advance of the 4th Army progressed great difficulty was experienced in the maintenance of the roads, and on October 12th all three Field Companies of the 1st Division and the Pioneer Battalion were sent up to the forward area to assist the 6th and 46th Divisions in the restoration of communications. The 23rd Company went to Mericourt, where it carried out work on the Fresnoy-Montbrehain and Montbrehain-Brancourt roads; water supply was another difficulty, and the construction of waterpoints was another important work at this time.

On the 15th, the award of the Military Cross to Lieut. Henderson was gazetted.

By the 16th, on which day the 1st Division once more moved into the forward area, the Corps was within measurable distance of the Sambre-Oise Canal (see Sketch No. 27), and a series of operations took place with the object of securing the line of the canal. For the attack of the Corps on the 17th October it was intended that the 1st Division should pass through the leading Divisions and exploit the canal, but owing to the thick mist causing difficulties in maintenance of direction and in keeping touch with the situation, the full results it had been hoped to obtain were not achieved, though a considerable advance was made. On the 18th, 19th, 20th and 23rd further advances were made, which brought the Division nearly to the canal on its right about Petit Cambresis and to the outskirts of Catillon on the left, where a portion of line had been taken over from the 30th American Division. On the 18th, the Company suffered a severe loss in the death of Lieut. Gates, who was killed whilst carrying out a reconnaissance in Wassigny.

During this period of steady advance the 23rd (Field) Company, which had moved to Vaux-Andigny on the 17th and thence to La Vallée Mulatre on the 19th, was still mainly engaged on work on roads —more especially along the north edge of Andigny Forest—and in repairs to wells.

THE SAMBRE-OISE CANAL, NOVEMBER 4TH.

And now, after four and a quarter long years, the 23rd (Field) Company was to fight its last great fight within a mile of Etreux, where it had so narrowly missed a serious mishap at the very start of its honourable service in France.

That the crossing of the canal in face of severe opposition was an operation likely to take place in the near future was apparent, and the general arrangements and preparations for the attack have already been described by Lt.-Colonel C. E. P. Sankey, D.S.O., in a previous number of the *R.E. Journal*.

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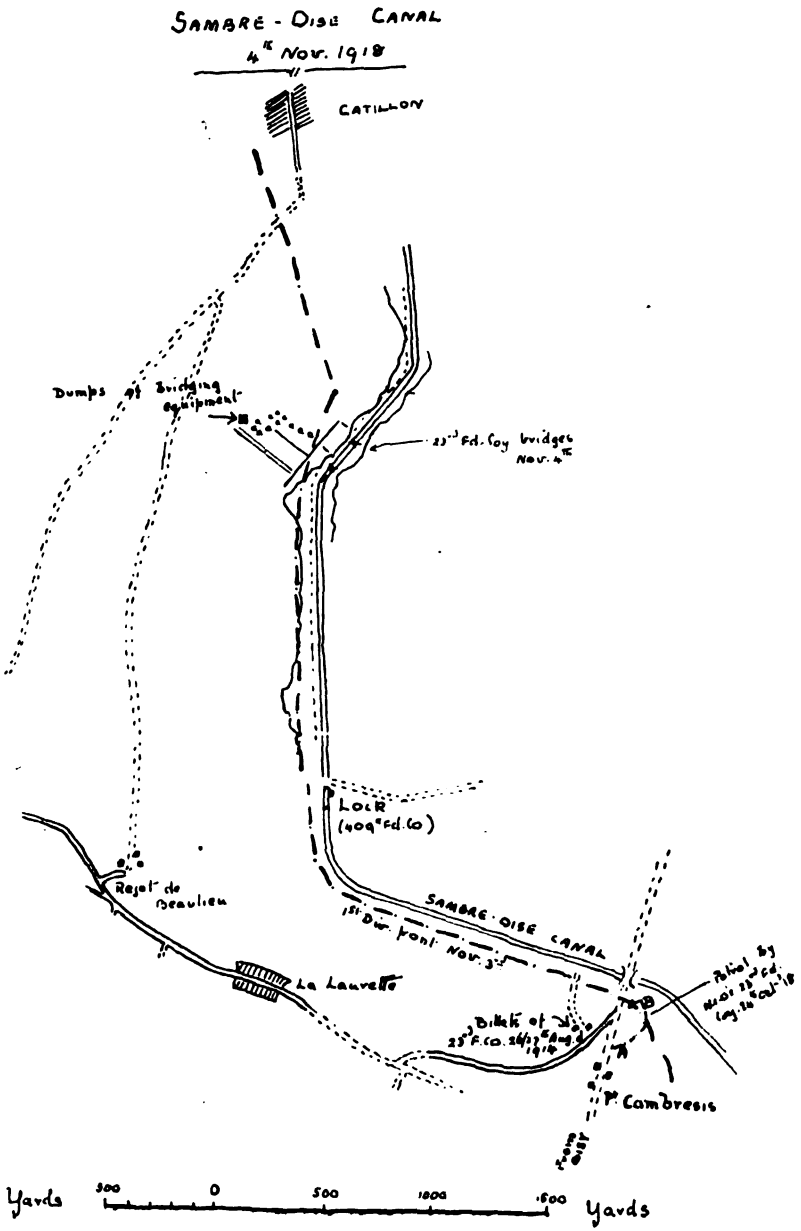
SKETCH No. 27.



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A certain amount of information collected from various sources, intelligence handbooks, aeroplane photos, civilians and so on, was available, but none of it sufficiently accurate or up-to-date as to be completely satisfactory when it came to getting down to the details of the bridging operations. Direct reconnaissance of the canal and its approaches was essential, a somewhat difficult matter with the Germans still on the near bank.

In the final attack on the 23rd October, the troops of the 3rd Brigade did just get within reach of the canal bank for a short time, but had subsequently to withdraw, an N.C.O. and Sapper of the 26th (Field) Company getting good information. On the night of October 24th, two N.C.O.s of the 23rd Company, accompanied by a patrol of one N.C.O. and two men of the 1st L.N. Lancs, attempted to reconnoitre the canal banks near Petit Cambresis Bridge (Sketch No. 27). They struck off from the road at A, but were soon stopped by a swamp, into which the men went up to their knees. Attempts to cross this swamp at various points were unsuccessful. The patrol then endeavoured to move up to the bridge, but on getting to within 100 yards were fired on by a machine-gun and had to withdraw. They were able to report that the hedges in the area were very close together and very thick, only passable in a few places.

On October 29th, a most valuable reconnaissance was carried out by Lieut. Roberts, of the 23rd (Field) Company, and as it is of considerable interest as a practical report by a field company officer made under difficult circumstances and in preparation for an important operation it is given below verbatim. (Sketch No. 28.)

"Attempts to clear the enemy's strong point during the morning had failed at the point at which it was desired to see across the canal.

"I reached Company H.Q., where it was reported that the western bank in M. 31 had just been cleared. I proceeded with three sappers to platoon H.Q. (1), thence with one sapper and a guide to outpost at (2). From here with the sappers to the embankment this side of the canal at (3), following the track shown in the aeroplane photograph and attached plan. Returning, I proceeded northwards to (4), and southwards to (5), the following information being obtained:

"The ground as far forward as the stream or ditch running through (4), (6), (3), (2), (7) and (5) is quite firm. This stream or ditch is 12 to 15 feet wide between (6) and (5). Northwards of (6) and southwards of (5) its width lessens to six feet. It can be crossed at (3) by individuals on a few old planks left by the enemy. Its banks vary from 18 to 30 feet in height above the water level. At (3) this stream runs close up against the embankment. Attached are rough sketches of the eastern bank, as seen from the top of the embankment at (3); also a similar sketch of the western side of the western embankment. From what could be seen of the eastern face of the western embankment north and south of (3) it seemed to be the same

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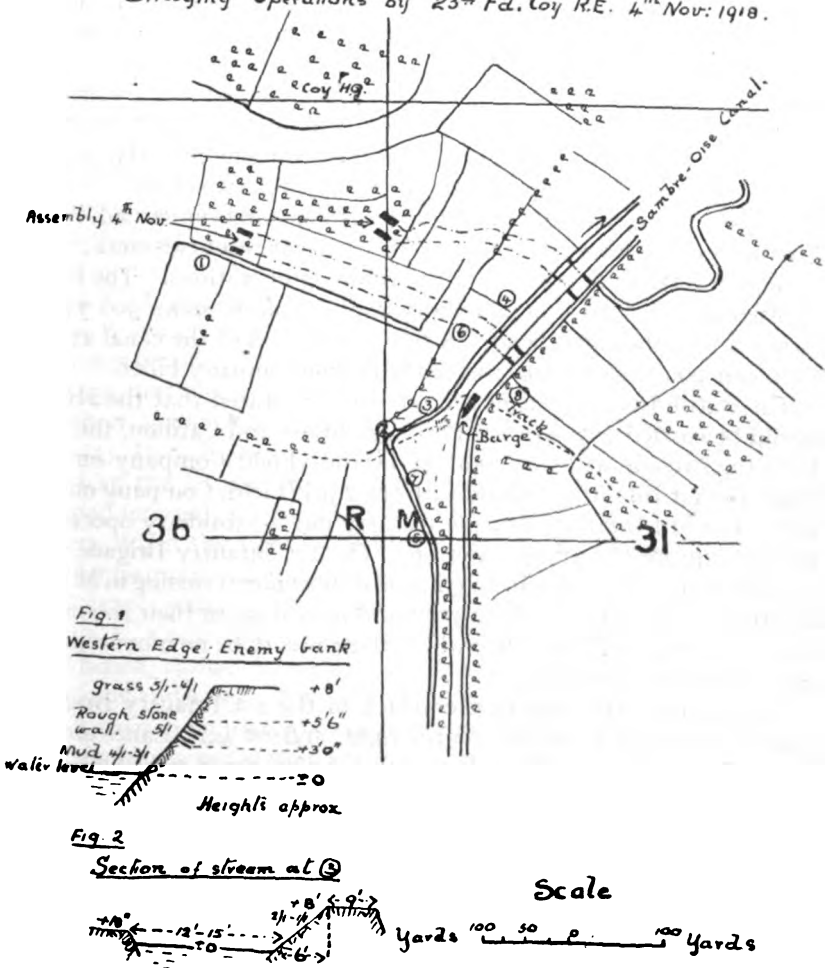
as the western face of the eastern bank. The height of the two embankments is the same.

"Attached is a sketch of the barge which is sunk in the canal at the bend. To me the width of the canal appeared to be about 20

SKETCH No. 28.

SAMBRE-OISE CANAL.

Sketch to illustrate reconnaissance by Lieut. ROBERTS, 29th Oct. and Bridging Operations by 23rd Fd. Coy R.E. 4th Nov: 1918.



yards. The trees which had been felled nearly all lie with their tips away from the canal, and appear to me to be only felled to clear the field of fire.

"There is a belt of wire about six feet thick running southwards

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from (3) for about 30 yards. A machine-gun could be seen firing at (8), but apparently could see nothing on top of western embankment under three feet high.

"Since the subsidiary stream is marked on the sketch plan supplied recently as a hedge, the hedges marked as such on the eastern bank seem also open to suspicion."

On the 29th October, Corporal Jones and a couple of sappers went out with an infantry patrol in Petit Cambresis, but were unable to get near the canal. They joined with a K.R.R. platoon which endeavoured to rush the enemy bridgehead post, but had to withdraw, Corporal Jones being slightly wounded.

On the 30th October, Lieut. Roberts again carried out a valuable reconnaissance of the approaches to the canal, the state of the roads and tracks and the concealment of the R.E. bridging material, which it was necessary to dump as near the canal as practicable.

As soon as the general scheme for the attack had been settled, Field Companies were allotted sectors of the canal for reconnaissance, with a view to settling the details of the bridging operations. The front allotted to the 23rd Company was approximately some 300 yards either side of the canal bend. A full scale model of the canal at the proposed point of crossing was made at the Company billet.

The Battle Instructions of the 1st Division stated that the attack would be carried out between Petit Cambresis and Catillon, the 2nd Infantry Brigade with the 409th (Lowland) Field Company on the right, the 1st Infantry Brigade with the 23rd (Field) Company on the left. The 3rd Infantry Brigade to carry out a subsidiary operation for the capture of Catillon later on. The 1st Infantry Brigade was to make its main crossing in M.31a, and a subsidiary crossing in M.26c. all troops to be screened from ground observation in their assembly areas by dawn on Z day, after which there was to be no movement of any sort before zero hour.

The leading battalions in the attack of the 1st Infantry Brigade were to be the 1st Camerons on the right, and 1st L.N. Lancs on the left. The 1st Infantry Brigade crossing was known as crossing No. 2.

The bridges for No. 2 crossing were sent up on the nights 1st-2nd, 2nd-3rd, 3rd-4th, 32 pontoon and G.S. wagon loads in all, and were dumped under trees and hedges and in orchards some 500–600 yards from the canal bank. This was no easy task. Constant shelling, cross-country routes, and heavy loads made the drivers' task a hard one. On one occasion a wagon upset in a shell hole, but 2nd-Corpl. G. Adamson, the N.C.O. in charge, in spite of the shell fire and having two horses hit, got his wagon up again, reloaded and the material safely delivered to the dump; a fine performance. About 2130 hours on November 3rd, the Company began to put the bridges together and to carry them to their final assembly positions. In addition, holes

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had to be made in hedges to enable carrying parties and the attacking troops to get forward, involving in some cases cutting trees up to 9 in. in diameter. This was a somewhat ticklish job, as German patrols had to be avoided. The trees after being cut were left standing, ready to be pushed down when the time came. Subsidiary bridges over the small stream west of the canal had also to be laid. All this work was completed by 3.30 a.m. on November 4th. The final assembly positions of the canal bridges are shown on Sketch No. 28, the four first-wave bridges being in front with four of the supplementary bridges behind. The remaining four supplementary bridges were left behind at the forward dump, where they were subsequently caught by the enemy's barrage and the equivalent of two bridges destroyed. The total length of infantry single-file bridging material constructed by the 23rd (Field) Company alone was 1,692 feet, including four German steel float bridges (324 ft.), two petrol tin bridges (144 ft.), four barrel bridges (264 ft.), two cork bridges (120 ft.), 36 single span bridges (360 ft.), and 48 ladders (480 ft.), representing a really good week's work for the carpenters.

At 5.40 a.m., in the dim light of a cold misty morning, the 23rd (Field) Company sections, each of which was responsible for one first-wave floating bridge, stood to their bridges, and were joined by the infantry detailed to assist, namely, a platoon of the 1st L.N. Lancs for the northern pair and a platoon of the 1st Camerons for the southern pair. The four sections were commanded by Roberts (No. 1), Dougill (No. 2), C.S.M. Simmonds (No. 3), Pocock (No. 4). At 5.45 the barrage commenced, and the bridges were lifted and carried forward, reaching the western banks of the canal five minutes later. When the right-hand bridges got to the canal, it was found that a German machine-gun post with five men was on the bank at the exact point where it was desired to put the bridges across. Serjt. E. Cook and Sapper G. F. Daycock, without a moment's hesitation, rushed forward and killed three of the enemy, the other two surrendering. The section officer was wounded, but Serjt. Cook carried on, over the embankment with a rush went the bridges, and in four minutes from the time of reaching the bank, Cook had his bridge across the first of all at No. 2 crossing. C.S.M. Simmonds, D.C.M., was in charge of the next bridge, and in gallant competition with Cook, got his bridge across second. He subsequently took charge of two sections, and by his drive and fine example got several more bridges across in quick time. A minute later, 5.55 a.m., the remaining three first-wave bridges were in position; each bridge carried two sappers at the head to fix the heads and place storming ladders against the further bank. Two stout-hearted sappers, Sapper L. H. Saunders and Sapper J. Sewell, M.M., having anchored their bridges, leapt ashore and proceeded to clean up two German posts on the bank. Saunders was wounded in the fighting, but never-

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theless returned to his bridge and carried out his job of keeping it in order during the crossing of the infantry.

Fine examples of gallantry and devotion to duty were shown by Lieut. J. C. Pocock and Sapper F. W. Kirby, both of whom were severely wounded almost immediately the bridging parties moved from their assembly positions. The former, however, continued to lead his party forward until he got to the canal bank, when he was able to go no further, handing over charge to the intrepid Serjt. Cook. Sapper Kirby continued to carry his section of the bridge to the canal, when he collapsed from his injuries, having worthily done his duty to the limit of his powers. Another gallant sapper was T. Williamson, who, having already shown his fine spirit in a daylight reconnaissance of the canal, now inspired all the men with him on his bridge by his cheerfulness under fire, his dash in being first man across his bridge, and his unconcern of danger. History relates that, when Sapper Watkins got through the barrage to Brigade H.Q. with his message that the infantry were across, the Brigadier threw his hat in the air, and ordered a tot of rum for the gallant messenger !

During this first bridging operation there was a fairly thick mist, which much assisted the parties carrying the bridges, and in addition the hostile barrage fell some way back from the canal banks, the total casualties amounting to one sapper killed and one officer and eight men wounded. After the first bridges had been placed, however, the men had to return and bring up the supplementary bridges, which were much heavier, men were tired, and progress was slow. However, by 9.15 not only were there ten bridges in position across the canal, but a corresponding number across the small streams east and west of the canal. No. 2 section was then left to maintain the bridges, and at 4.20 p.m. the remainder of the Company withdrew.

The Company was remarkably fortunate in getting their bridges across so rapidly with so few casualties, in contrast to the bitter fighting and severe shell fire experienced by the 409th (Field) Company at the lock. The writer may be forgiven if he here expresses his unbounded admiration for the splendid performance of his old friends of the Lowland Field Company on that day, an achievement which put a fitting seal to the grand record begun so well on the night of January 11th, 1915.

As a result of these operations the following officers and men received immediate rewards for gallantry and devotion to duty.

Major W. G. Smith, M.C., to whose splendid example and cheerfulness and organizing ability the success of the bridging operations, and particularly of the delicate work of the collection and concealment of the material was mainly due, received the D.S.O.

Capt. D. H. Gillespie, who had charge of the difficult and particularly unpleasant job, once the German barrage commenced, of regulating the supply of material, received the Military Cross, as

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did 2nd-Lieut. J. C. Pocock. C.S.M. F. E. Simmonds, D.C.M., M.S.M., who not only took such an effective part in the actual bridging operations, but also assisted Captain Gillespie, and to whose cool courage under heavy shell fire the smooth supply of bridging material was largely due, received a bar to his D.C.M., whilst those hard-fighting soldiers, Serjt. Cook, Sappers Daycock and Saunders, received the D.C.M., Sapper Sewell won a bar to his Military Medal, whilst the following, who by their conduct under fire and continual devotion to duty worthily upheld the tradition of the 23rd (Field) Company that day, received the Military Medal: Serjt. E. Banham, Corpl. J. Bostock, Lce.-Corpl. J. P. Trussler, Lce.-Corpl. J. A. Elliott, Sapper A. Hocking, Sapper S. C. Evans, Sapper J. Newis, Sapper F. W. Kirby and Sapper A. G. Watkins, who, as Company runner, carried his messages safely and without delay backwards and forwards through the heavy barrage, and was the first man to get news to Brigade H.Q. of the successful crossing of the canal within three-quarters of an hour of zero.

Sappers Kirby and Williamson, whose individual gallantry has been referred to in the narrative, and 2nd-Cpl. Adamson, also received the Military Medal.

A very sad loss this day was that of Sapper Woolcock, M.M., No. 2 Section. This gallant sapper had been all through the War with the Company, conspicuous for his fine courage, and on this day, having volunteered for the dangerous duty at head of his bridge, he was severely wounded after carrying out his task, and died in hospital, the last man of the Company to be killed.

This was the last engagement in which the Company was to take part in the Great War, for on the 5th they rested, on the 6th moved to Lernoy le Grand, whilst on November 11th the diary prosaically remarks "Company employed packing surplus stores for removal to Bohain"!!

THE MARCH TO THE RHINE, THE OCCUPATION AND DEMOBILIZATION.

It but remains to tell briefly the story of the occupation. The march forward commenced on November 13th, in very fair weather. The underlying weight of war, which had insensibly been ever present for four and a quarter long years, day and night, was lifted, hearts were high even if, thanks to the destruction of communications, stomachs were light. At last the great day had arrived; "To the Rhine!" with backs turned for good on the pestilential battle areas in which the sapper had dug and delved for so long. What can have been the feelings of the 36 stalwarts who had set sail from Southampton on that August day in 1914 and had seen the "Old Bat." through its great campaign?

Loads were cut down to the minimum, the souvenirs, tools and

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gadgets dear to the heart of section officer, serjeant and cook, were jettisoned ruthlessly, till carts contained nothing but mobilization stores. During the early stages of the march the Company was kept hard at work removing land mines, which the thorough German had placed at every cross-road, culvert, embankment and bridge, mostly well tamped. Two officers on motor-cycles were employed keeping touch with the German rearguards and placing civilians to point out the positions of the mines. It was not until the 18th that the Division was clear of the mined area.

The people seemed rather stunned, and were in sad straits; they had no stock and no tools, little but a few potatoes. At Yves Gomezee, however, they turned out quite a creditable band, the drum filling in any gaps in the efforts of the wind experts.

At one place a large park of German aeroplanes was seen, and it was interesting to note the large numbers of bullet marks in wings and fuselages.

Towards the end of November and beginning of December the weather broke, and marching day by day became somewhat unpleasant, but none grumbled, for all felt they were on the right road. Every mile gave evidence of the German troubles, burnt-out lorries, lorries with no petrol, and with iron tyres.

A halt was called for the week-end on December 14th, and all hands turned to polishing buttons, cleaning up wagons, and harness, in preparation for crossing the frontier.

On December 16th, the 1st Division crossed the frontier at Beho, marching past the Divisional Commander with bands playing and the Union Jack flying on enemy territory at last. It was a brave sight, in spite of the rain which was "tumbling down." At the end of the day's march the men were well treated, the housewives providing big fires to dry the soaked clothing, whilst a dish of potatoes in many cases, and even a mysterious chicken, found its way occasionally into the stewpot.

At last, on December 23rd, the Company arrived at its final billet, Niederdress, where it had the village to itself. Christmas Day was celebrated under the happiest conditions, pig, poultry and something to wash them down all helping, and every section had its own sing-song.

Very soon in January and February, demobilization began, time-serving soldiers leaving early to help in the work at the depots at home, and by March and April the process was in full swing, until the day came for the cadre of Captain A. E. Green, M.C., R.E., and some 40 men to move to Antwerp on May 23rd, where they embarked in the s.s. *Arbroath* on the 29th, arriving at Tilbury on the 30th, coming to rest at Chattenden on the 31st, reduced to a care and maintenance party of C.S.M. Simmonds, D.C.M., M.S.M., and one sapper. All honour to the "Old Bat." and the men, regulars and "temporaries" alike, who had maintained its reputation bright and unsullied through four and a half hard fighting years.

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AFTERWORD.

I cannot bring this tale to a close without offering my very grateful thanks to all those who have suffered my importunities and have helped me to "paint the picture," in particular Captain B. B. Edwards, M.C., R.E., and C.S.M. F. Simmonds, D.C.M., M.S.M. (late R.E.), both of whom have contributed very liberally to the narrative. My thanks are also due to the officials of the Historical Section, Committee of Imperial Defence, for unvarying helpfulness, to Major Becke, for guidance and assistance with sketches, and Mr. Woolgard (late R.A.), who kept me supplied with the Company, C.R.E.'s, and other War diaries; to Colonel C. Russell-Brown, C.B., D.S.O., Major G. Cheetham, D.S.O., M.C., R.E., Captain M. W. Salmon, M.C. (late R.E.), and Lieut. P. L. Forwood (late R.E.), all of whom materially assisted the work.

Unfortunately, a Field Works book kept by the Company, which included sketches of all the works carried out from 1915 onwards, disappeared after the Armistice, so that technical details of interest have been difficult to obtain at this distance of time.

THE 23RD (FIELD) COMPANY, R.E., 1914–18.

APPENDIX E.

Note.—As it is thought that some of the Company statistics will be of interest, the following tables are given.

TABLE I.

Casualties to the Original 1914 Personnel.

Officers.	Wounded	1	
	Sick	2	
	Transferred	3	
	Total	6	

Of the three transferred, all served throughout the campaign in France, almost entirely with Divisions.

Other Ranks.	Killed	27	
	Wounded	50	
	Sick	73	
	Transferred	32	
	P. of W.	3	(caught in the mine at Cuinchy, Jan. 25th, 1915).
	Served throughout the War	36	(of these 5 continued serving after the War).
	Total	221	

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TABLE II.

Half-yearly Casualties (including wounded, at duty, and sick rejoined).

	Killed and Wounded.	*Sick.*	*Total.*	
Aug., 1914 –31.12.14 ..	27	47	74	
1.1.15–30.6.15 ..	51	40	91	Cambrin and Rue du Bois.
1.7.15–31.12.15 ..	59	28	87	Battle of Loos.
1.1.16–30.6.16 ..	10	20	30	Loos sector.
1.7.16–31.12.16 ..	42	27	69	Somme.
1.1.17–30.6.17 ..	3	48	51	
1.7.17–31.12.17 ..	9	35	44	Passchendaele.
1.1.18–30.6.18 ..	48	34	82	Givenchy.
1.7.18–31.12.18 ..	38	28	66	
	287	307	594	

TABLE III.

Battle Casualties by Sections (*excluding wounded at duty*).

	Killed (Officers)	*Wounded (Officers)*	*Killed (O.R.)*	*Wounded (O.R.)*	*P. of W.*	*Total.*
No. 1 Section ..	2	3	16	46	3	70
No. 2 Section ..	–	2	11	47	–	60
No. 3 Section ..	–	2	10	38	–	50
No. 4 Section ..	–	2	5	56	–	63
H.Q. and Mtd. ..	–	3	9	24	–	36
	2	12	51	211	3	279

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ANTI-AIRCRAFT GUNNERY.

A Lecture delivered at the S.M.E., Chatham, on March 14th, 1929, by CAPTAIN V. R. KROHN, M.C., R.A.

Introduction.—The period of a normal lecture is too short for more than a general outline of the various and somewhat intricate problems confronting the A.A. gunner. If, therefore, I appear to pass some matters of interest rapidly, the shortness of time is to be blamed.

Reasons for Ground A.A. Defence.—The first line of Anti-Aircraft defence is the aeroplane.

An aeroplane cannot, however, remain in the air continuously. The average "fighter" carries sufficient petrol for from 2 to 2½ hours' flight. Allowing for overhauls, etc., in order to keep one aeroplane patrolling continuously during the hours of daylight in summer, a complete "flight" of six machines with their pilots and ground staff is needed.

One has to remember also that the pilot himself can only fly for a limited number of hours each day.

From this we see that unless we had an almost unlimited supply of aircraft and pilots, some other form of A.A. defence must be found to supplement the defences in the air, and it is for this purpose that ground A.A. defences were introduced.

The primary *rôle* of ground A.A. is obviously the attack by fire of hostile aircraft with the object of destroying them, but there are other almost equally important *rôles* such as :—

(*a*) breaking up enemy formations to allow our fighters to deal with the units thereof.
(*b*) pointing out hostile aircraft to our own patrols.
(*c*) protecting our own artillery observation aircraft from hostile attack, by means of barrage fire, or by direct fire on the enemy machine.
(*d*) protecting our observation balloons as in (*c*) above.
(*e*) protection of vulnerable points or areas against attack by bombing aircraft.
(*f*) recording movement of all aircraft, particularly hostile. From these records very valuable information can frequently be deduced by the General Staff.

What A.A. have we got ?—At present we have to have A.A. units for the following jobs :—

i. Expeditionary Force.
ii. Defence of London.
iii. Defence of Home Ports.
iv. Defence of Ports Abroad.

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For the Expeditionary Force and London Defences we have A.A. units grouped into Air Defence Brigades.

For home ports and ports abroad special organizations are arranged depending on local requirements.

The composition of an Air Defence Brigade is shown on the diagram.

Guns.—The standard gun for all purposes is at present the 3-inch 20-cwt. A.A. gun. This throws a 16-lb. shell to a maximum height of about 21,000 feet in about 30 seconds.

Actually its effective height is between 16,000 to 18,000 feet, for which the time of flight is about 25 secs.

The 16-lb. shell can be either H.E. or shrapnel. In the former case the shell breaks up into about 150 pieces averaging a little less than 2 oz. in weight.

H.E. is the normal type used, and is issued with shrapnel in the proportion of 85% to 15% respectively.

The shrapnel is used mainly against low flying attack, where the forward effect of the shrapnel bullets is useful, and also for putting low barrages over places such as bridges, where the use of H.E. would be dangerous to troops on the ground.

Experiments are being carried out with a 4·7 inch A.A. gun, but this will only be used for fixed or semi-fixed defences, as it is too heavy for mobile work.

Fire Unit.—In all cases the basic minimum fire unit is the 2-gun section.

Whenever possible, however, 4-gun fire units will be used for two reasons :—

i. Volume of fire.
ii. Better and more economical control.

How does A.A. get about?—We have at present three types of platform on which we can carry our 3-inch gun and mountings, and in each case the gun and mounting are identical :—

i. Platform travelling A.A. mounting No. 2 Mark I.

This was introduced into the Service in 1928. It is a trailer type platform with four wheels, and towed by a four or six-wheel drive tractor. In action the weight is taken on four jacks, but in an emergency the gun can be fired from the unjacked platform without danger. The platform is well sprung, and can travel safely at any speed that a Service tractor is likely to be capable of. It is steady in action, and the gun can be fired horizontally without undue shaking. It can be got into and out of action in two or three minutes.

Expeditionary Force units are now being equipped with this.

ii. Platform travelling A.A. mounting No. 1 Mark I.

This is what is generally known as the semi-mobile platform. It is square in plan, and can be fitted at will with two detachable wheels.

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At each corner a girder is hinged, which carries a long jacking screw at the outer end. When in action the girders are swung outwards, forming a sort of starfish platform which can be levelled by means of the jacks. For travelling, the whole platform is jacked up, the wheels fitted, and then the girders can be folded in pairs, one girder of one pair being fitted with a sprung towing-eye which hooks on to a special towing-bar fitted to a tractor or three-ton lorry.

This platform is very steady when the gun is firing, but is sufficiently handy for moving when necessary. It takes from 10 to 15 minutes to get into and out of action.

iii. Lorry mounting.

This platform is obsolescent, but is retained as a reserve mobile mounting. It is simply a lorry chassis fitted with four jacks, the gun being mounted on the floor above the rear axle. It is unsteady in action, and generally unsatisfactory.

Why not fixed like Coast Defence.—Fixed A.A. guns on concrete platforms would be ideal for such defences as London, etc., but it would involve tremendous capital expenditure, and further enormous sums in maintenance.

Secondly, by having these semi-mobile mountings, which can be moved about comparatively easily, in the event of a war which does not involve fleet action, those guns earmarked for the A.A. defence ports abroad could be used on the L.-of-C. and so on.

Searchlights.—These are necessary for night work. Without them, our own defending aircraft are also useless at night, so that searchlights are of the first importance. We have at present two types of searchlight :—

i. 90 centimetre—mobile.
ii. 120 centimetre—used for fixed defences only at present.

A new high-current density lamp is being introduced for the 90-cm. searchlight, which gives a considerable increase in range. Up to the present there is no lamp of this type for the 120-cm. searchlight.

The efficiency of any searchlight is so dependent on atmospheric conditions that it is often misleading to give any figures as to range. Under good conditions, however, the range of the new lamp may be taken as from six to eight thousand yards, measured along the beam.

The illumination required by the gunners is greater than that required by the Air Force. When laid out for the illumination of targets for gun defences, the lights are spaced about 3,000 yards apart all over the area. This system allows for illumination to be given by three lights at a time, and is then sufficient to allow the gunner to take the measurements he requires.

When laid out for the illumination of a target for the Air Force only, the spacing of the lights is increased to about 3,500 yards.

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For the gunners, it is necessary to get the target definitely into the beam. For the Air Force, it is frequently sufficient if the hostile aeroplane is to be found near the intersection of two searchlight beams which are following it by sound but not actually illuminating it. In such a case, a fighter machine can fly towards the intersection of the searchlight beams (which may even be above a bank of clouds), and locate the hostile machine either by the flame from its exhaust, or by seeing it in silhouette, or faintly illuminated by diffuse light.

Sound Locator.—The sound locator is a necessary adjunct to the searchlight, and is used for directing the light on to the target.

The principle upon which the sound locator functions is the use of the binaural effect obtained with the human ears. Briefly this binaural effect is as follows :—A sound arriving from a fixed source which is not directly in front of an observer arrives at one ear a fraction of a second before the other, thus enabling the observer to get an idea of the direction from which the sound emanated.

If the observer commenced to turn his head in this direction, there would come a time when he would appear to hear the sound at the same instant, or at even intensity in both ears. He would then be looking in the direction from which the sound emanated.

The normal distance between the ears of a human being is only a few inches, and therefore the accuracy with which direction can be determined is not very great. If, however, we lengthen this base artificially, to some feet, the accuracy is increased in direct proportion. Furthermore, if we introduce at the same time some means of amplifying the sound, we further increase the accuracy.

Both these points are achieved in the modern sound locator. Two large trumpets separated by a distance many times that of the ears, are mounted parallel to one another, and, from the narrow end, tubes, terminating in stethoscopes, are taken to the ears. The trumpets are of such a shape that amplification of the sound is obtained.

If now, these trumpets are mounted so that they can be revolved about a vertical point, the observer will be able to swing them until the intensity of the sound is even in both ears, and direction will have been obtained.

With the aeroplane target the job is somewhat more complicated, as we require direction in two senses, *i.e.*, bearing and elevation. This is achieved by using two observers, each supplied with a pair of trumpets. The trumpets, however, are now mounted on axes at right angles to one another, so that observation for direction can be obtained in two planes at right angles to one another. The movements now given are, therefore, about two axes, one vertical and one horizontal, so that bearing and elevation can be read from appropriate scales.

A further point which must be taken into account is that of sound "lag." With a fixed source of sound this does not affect the readings,

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but with a moving source such as the aeroplane, the readings on the scales at any given moment would correspond to the position of the target displaced from its present position, by the distance it travelled in the time the sound took to reach the observer.

For example: At the moment of observation, the aeroplane was 3,300 yards away, or 9,900 feet.

Sound travels at 1,100 feet per second, so that $\frac{9900}{1100} = 9$ seconds, is the time it took for the sound to reach the observer.

If the aeroplane was travelling at 100 miles per hour, = 50 yards per second, then at the moment of reading on the sound locator scales the aeroplane would be 9 x 50 = 450 yards further along its course.

At the present time this is allowed for by the use of a certain type of sight known as the ring sight, but space will not permit of a description being given. It is hoped, however, that in the future some more accurate and automatic method may be evolved.

Signals.—As will be seen from the Table, there is a Signal Company to each Air Defence Brigade.

The units of this company are responsible for all the signals required within the Air Defence Brigade, down to Battery H.Q. in the case of the A.A. Brigades and to Sections in the case of the Searchlight Battalion.

Internal signals in the batteries, etc., are carried out with their own personnel and equipment.

The actual composition of the Signal Company is at present under revision.

A.A. Lewis Gun Sections.—There is one of these sections to each A.A. Battery. At present it consists of eight A.A. lewis guns carried in two vans or light lorries, but it is likely that these will be replaced in the near future by a multi-gun mounting, mounted permanently on a six-wheeled vehicle, as in this way a much greater volume of fire could be produced. If this scheme matures, it is likely that the total number of gun barrels will be increased.

The function of these guns is the protection against low-flying attack of units which have no protection of their own, such as ammunition, ration and supply dumps, etc. They are also used for picketing defiles, bridges, etc., on the line of march.

The existence of these guns in an area does not excuse units in that area from organizing their own A.A. lewis gun defences.

What A.A. has done and hopes to do.—Many of us still have vivid memories of seeing the hostile aeroplane in the sky, and, anything up to two miles away, some A.A. shells bursting on their own. Or one saw a hostile plane travelling on a straight course, followed about 500 yards behind by a string of A.A. bursts.

The first trouble may still occur. It was and will be due to the fact that the target turned just after the rounds left the guns, or at some time during their flight from the gun to the target. This is not

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the A.A. gunner's fault, although it was frequently thought to be so, and he came in for a considerable amount of scathing comment which was entirely undeserved.

The other case was due to inexperience and the lack of efficient fire control instruments.

During the Great War, A.A. gunnery was very much in its infancy; there were few instruments, some of which were merely adapted in a vain effort to solve a problem to which they were entirely unsuited.

Since the War, however, the development in A.A. gunnery has been more rapid than almost any other contemporaneous Service development, excepting always the improvement in aeroplanes themselves, but we have, I think, kept pace with them.

It has been calculated that, it required to hit a target

at the outset in 1914, 100,000 rounds.
In 1916, 10,000 rounds.
At the end of the War, 3,000 rounds.

Now, we may reasonably place that figure at 100 rounds. Of course, in peace time a figure of this sort can only be based on estimation.

In spite of indifferent A.A. shooting during the War, anti-aircraft fire accounted for one out of every 12 hostile aircraft brought down. This is a higher proportion than is generally realized.

What A.A. cannot do.—We can compete with an invisible target only by putting up barrages, most wasteful in ammunition and the last resort of the A.A. gunner. We are, however, developing methods by means of which a barrage point is predicted, and a limited fire is opened at a given moment. If the prediction has been good, it is quite likely to have one or both of two effects if the hostile machine is a bomber, even though the aeroplane is not hit,

(*a*) It may turn it, or

(*b*) it may cause him to drop his bombs and go home.

Such results were frequently obtained from well directed barrage during the War.

Some of the A.A. Gunner's Difficulties.—(i) We are working in three dimensions, and if we consider the time factor which is all important, we then work in four dimensions.

Speed.—(ii) The speed at which our targets travel are at the bottom of our troubles. Nowadays, a slow speed is 100 m.p.h. A normal speed is 150 m.p.h.

100 m.p.h. = 50 yds. per sec. 150 m.p.h. = 75 yds. per sec.

Extreme Range.—(iii) We have to tackle our targets at extreme range in order to keep them away from our vulnerable points or areas.

This means that we are usually working at the most inaccurate part of our trajectory.

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Observation.—(iv) Any observations that are necessary, such as height, etc., are made very much more difficult by not only speed, but background. Certain types of sky give us beautifully defined targets, but on most apparently clear days there is a high haze which blurs outline and frequently completely obliterates targets.

The Gunnery Problem.—Height. (i) With such a fast-moving target all the ordinary factors such as range, bearing and so on, which are common to all gunnery and which are usually stationary once they are found, are changing very rapidly in A.A. gunnery. In a search for something which is likely to remain more or less constant we find that *Height* should fill the bill. Unless disturbed, a pilot will fly at least at approximately the same height for considerable periods. Height is, therefore, the basic measurement in A.A. gunnery, and all subsequent calculations depend on obtaining the correct height.

Speed and Course.—(ii) For the same reasons, speed and course are likely to remain fairly constant. Height, speed and course are, of course, all subject to involuntary changes due to atmospheric conditions.

Three Assumptions.—(iii) In order to make any headway at all it has been found necessary to make the following assumptions :—

That for a given target :—

1. Height
2. Course
3. Speed

will remain constant over a short period.

Obviously, the shorter the period the better, but unfortunately we are limited in this by the performance of our gun. The shortest possible period at a given moment is the time that it will take the shell to reach the aeroplane (or the time of flight). This presupposes that no time at all is lost in making our calculations. I will try to show you in a minute, that we have practically achieved this now.

Measurement of Height.—As is so often the case, we have, I regret to say, put the cart before the horse in A.A. gunnery. What I mean is this. Height being the basic measurement in A.A. gunnery, it is not much use thinking about anything else very seriously until we can get an accurate height whenever we want it. At the moment we can't do this, although we can do almost everything else that is required with considerable precision.

We ought to get our height to within 50 to 100 feet, but if you asked a surveyor to get you the height of a mountain 6,000 feet high, he would take perhaps an hour to collect his instruments, another to take his readings, and calculate the answer. We want the answer in under 30 seconds.

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At present we have two main systems :—

(i) The short base method.
(ii) The long base method.

(i) *Short Base Method.*—This consists of the ordinary type of Barr and Stroud rangefinder, with which all branches of the Service are familiar, only it has a 2-metre instead of a 1-metre base. Attached to it is a complicated gear box which hatches out the height for you, when you mount the instrument on a levelled stand and feed it with angle of sight as well as range. This instrument isn't so bad up to about 8,000 feet, but after that it fails miserably.

Further research on these lines is being pushed on hard.

(ii) *Long Base Method.*—In this case, we have two instruments at the ends of a base perhaps 6,000 feet long. The stations are connected telephonically and readings from one end sent to the other, where, after a single setting has been made, the height can be read off. The answer is pretty accurate, but as a service heightfinder the method is full of snags, which I will leave you to think about at your leisure. I suggest, however, that for one thing a 2,000 yard telephone line is not too easy to keep in order in a place like the Ypres Salient. I've tried it.

Here, again, research is being carried out, and we hope for answers in the near future.

Deflections.—I think it is obvious to the most inexperienced that it would be useless to fire at the aeroplane at the position in space which it is occupying at the moment of firing, because the shell takes time to get there and in that time the aeroplane is also moving, and pretty fast, too.

Example : If time of flight is 20 sec. and speed is 75 yards per sec., then distance travelled equals 1,500 yards.

Future Position.—We must, therefore, fire at some future position of the aeroplane which, assuming the height remains constant, is dependent on :

(i) Speed.
(ii) Course.
(iii) Time that it will take us to put a shell in that future position.

In other words, we must give the guns a " lead " in the direction of the target's flight. This is done by applying on the sights, deflections for travel in two senses :

(i) The vertical sense.
(ii) The lateral sense.

(i) is known as the vertical deflection, and may be " up " or " down," depending on whether the target is travelling towards or away from the guns.

(ii) may be " right " or " left." This is self explanatory.

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Angular Velocity.—Up to the present we have talked at length about "speed" and "course" of the target. By this we have meant the speed and course relative to the ground.

A target may quite easily have an "air speed" of 60 miles per hour, but if it is travelling into a 60 m.p.h. wind its "ground speed" at that moment is *nil*, and its course is stationary.

Now, in actual practice, for reasons we cannot go into here, we have found that it is not convenient to try and measure the actual ground speed and course of the target. We can, however, very easily measure what we call its "angular velocity." That is to say, supposing we had a target travelling directly away from us, its angle of sight (or elevation) is changing all the time; getting less, as a matter of fact. If we measure the rate at which this angle is changing we have found the "vertical angular velocity." If, now, we made that target travel away from us and to the right, say, at the same time, its bearing relative to true north or some chosen point is also changing at a certain rate, which can be measured. This is the target's "lateral angular velocity." In this case we have a bit of vertical and a bit of lateral angular velocity, and this, if you will think for a minute, is likely to be the usual state of affairs.

If, then, we multiply these angular velocities by the time of flight which we have already mentioned, we will get angles, in the same way that, if we multiply the speed at which we travelled from London to Chatham by the time that it took us, we will get the distance from London to Chatham. These angles are the travel deflections we have just talked of. In actual fact, they are subject to certain corrections which we need not go into here, but the principle remains true.

Crossing Point.—It is interesting to note here, that although we can have targets which will approach or recede directly, giving us no lateral rate at all, we cannot have the converse except momentarily. Take any target crossing our front from, say, right to left; at first it has an approaching element as well as a lateral element. When it arrives plumb opposite us, or, in other words, reaches the point on its course which is nearest to us, the approaching element changes to a receding element, while the lateral element remains "left." The moment of changing over is known as the crossing point, and it is at this point only, that we have a purely lateral element, and it is only momentarily.

Fuze.—We have seen that we want two deflections for travel, but we want also a fuze. Actually, what we really need is what other gunners think of as range, but A.A. gunners think of it as fuze-range. This is not just to make it more difficult, but because we find that the easiest way of applying range is in terms of fuze and angle of elevation. There is a dial on the gun which has fuze curves on it, which must be followed to order by the operator. The following of any

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given fuze curve on this dial automatically applies the correct elevation for that range to the gun.

This fuze must, however, be found somehow, and as it is the fuze to the future position which we require, and not to the present position, and as we don't yet know where this future position is in space, you will begin to see that our problem is not a simple one. To go a little further with this intriguing picture, until we know what the fuze is, we don't know what the time of flight is. Until we know what the time of flight is we cannot possibly get our travel deflections. So it looks as if we are dooomed to go round and round in a circle like a kitten chasing its tail. As a matter of fact, it is all worked out on a system of balancing, or trial and error, and as our instrument does it for us almost automatically, I don't think we will bother with it any more. The method is known as obtaining the "A.A. balance."

Summing up, then, we have now got for our guns:

(i) Vertical deflection.
(ii) Lateral deflection.
(iii) Fuze.

With these three things available we can fire the guns and hope for the best.

Methods of Application of Gun Data.

We can apply the data now obtained in two ways:—

(i) To dials on the gun sights in the form of deflections, etc., given above.
(ii) Or as composite elevation and training angles direct from instruments to electrical follow-the-pointer receiving dials specially fitted to the guns.

Case I.—The first system is known as the Case I method, and as the various information must be read off from dials on the instruments, shouted to the guns, and there applied to the sights, you will see that a lot of valuable time will be wasted and the result will be that the deflections, etc., are likely to be stale by the time that the guns fire. In actual fact this "lost" or "dead" time is, on an average, about eight seconds, so that unless one did something about it, at 75 yards per sec. the target will travel 8 x 75 = 600 yards, and that is what one would miss the target by. Actually, allowances are made, but so far they have been dependent on the skill of the individual members of the instrument detachments, and this is not good enough.

Case III.—The second system is known as the Case III method, and is a very different story.

Here, all the necessary data is evolved inside the instrument, and sent down continuously to the special follow-the-pointer receiving dials on the guns, so that all rounds are fired with the correct sight

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settings. This means that we have eliminated completely and accurately the whole of that dead time of eight seconds, so that we can hope to be at least 600 yards nearer the 150 miles per hour target every time.

Group Fire.—With the Case I method, as it is impossible to cope with the continuously changing fuze by a corresponding continuous change at the guns, we fire groups of four rounds set at the same fuze. This is theoretically inaccurate, of course, but cannot be avoided in this method, even though we resort to an automatic fuze setter.

In Case III we can transmit the fuze continuously to an automatic fuze setter, so that each round is set at the correct fuze, so we gain here also.

The Predictor.—The modern A.A. instruments which are used to give us the data we have been talking about are :—

(i) A height finder.
(ii) An anti-aircraft predictor.

The height found by the heightfinder, is set into the predictor. The predictor is kept laid continuously on the target by two men. Other members of the predictor detachment perform comparatively simple operations such as following a curve or by means of a hand-wheel, preventing the revolution of a pointer visible in the dials opposite to them.

Further settings in the predictor are :—

(i) For the effect of the wind on the shell. The strength and direction of the wind in the district is set into the instrument, together with another setting of height of target, and internal mechanism works out continuously and automatically the corrections required, and these are automatically applied to the main data before they are transmitted to the guns.

(ii) Corrections for temperature, barometer and wear of guns are worked out and applied as a percentage correction to the height of the target. Therefore the height used in the predictor will not necessarily be the actual height of the target, but what is known as the ballistic height.

Secondary Methods.—We have under trial at the moment two secondary methods. Both are of the Case I type, but allow more or less automatically for the " dead " time I have spoken of. As they are experimental, I will not do more than mention their existence. It is sufficient to say that they are required as substitutes for the predictor either in case of breakdown or in cases where the fire unit must be split, or again, in some very forward and dangerous position where the risk of getting the very expensive predictor hit was considered too great.

Eye Shooting.—As a last resort, when all else fails the unfortunate A.A. gunner must take to eye-shooting. This is really a process of

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calculated guessing, the mental calculations being based on certain rough rules. Most of the shooting in the War was carried out in this way, and it seems that to be successful is to have the gift for it, though a great deal can be learnt by study of the subject. Furthermore, modern methods and ideas have certainly gone a long way towards making eye-shooting easier.

A.A. Fire Control.—Generally speaking, it is impossible to obtain really accurate shooting without the use of instruments. The more accurate the shooting required, the more expensive and elaborate are the instruments.

This does not mean, however, that the work of the A.A. gunner becomes more difficult, but rather the reverse. The more complicated the instrument, the more completely automatic does it become, and so the actual operations performed by the members of the detachments become easier.

It is no exaggeration to say that a squad of intelligent young recruits should make an exceedingly efficient A.A. Section, and they could be trained to a very reasonable state of efficiency in a very short time.

It is the secondary system, including eye-shooting, which requires so much training.

The Case III method of fire is now the proven orthodox method of A.A. attack.

Every effort is, therefore, being made to perfect instruments and other gear to the most profitable employment of this method for both mobile and fixed defences.

Methods of Practice.—This lecture would not be complete without some mention of the methods of practice of A.A. fire. It is obvious that we cannot actually shoot at a real aeroplane unless it could be controlled by wireless, and even then it would be an expensive business, because I have always found that when we are not particularly keen on bringing down our target, we generally succeed in doing so. There were occasions in the War in which our own or Allied planes were engaged by mistake, and I don't think we ever missed.

Two Methods.—At present we have two methods:

(*a*) Full charge shooting at a towed sleeve.

(*b*) Reduced charge shooting at an actual aeroplane.

(*a*) *Full Charge.*—In this case an aeroplane tows a 20-foot long sleeve about 2,000 yards behind at heights up to about 10,000 feet. So far, for safety reasons we can only shoot at this sleeve when it is crossing our front and then only through a limited arc of fire.

We do not record a large number of actual hits, because we use a special cheap cast-iron shell which breaks up into about ten pieces. The Service H.E. shell breaks up into about 150 pieces.

Hits.—In 1928, the R.A.F. calculated that we got about one hit for 1,300 rounds fired, so that on this basis with the Service shell we ought

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to do about 15 times better, which would mean a hit every 80 or 90 rounds. Of course, a hit does not by any means mean disablement. I knew a pilot in the R.F.C. who returned one day with 370 odd holes in his machine from A.A. as well as small arms fire, but no vital part was hit. The machine was, of course, written off. This year we are going to fire some H.E. shell at the sleeve, so we hope to get more definite information.

(*b*) *Reduced Charge.*—By arranging to use a very much reduced charge we have been able to reduce the ceiling of our 3-inch gun from about 21,000 feet to 8,000 feet, and yet arrange that the times of flight for given fuze lengths are practically the same as with full charge.

By making the aeroplane fly above 8,000 feet, we ensure the pilot's safety.

By providing special scales for our instruments we can make them function absolutely normally.

The only difference is that the shell is only sent to about half-way to the target, although it takes about the same time to do this as the Service charge would take to send it the whole distance. This means that deflections are of the same order, and an effective round is taken as one which bursts on the line of sight to the target at that moment. This is a more reasonable assumption than may be at first imagined, because we also take steps to check the height ordered. A.A. gunners are the first to admit, however, that this method is not so satisfactory as being able to record actual hits.

The outstanding advantage of the reduced charge method is that there is no restriction on the movement in space of the target other than range limitations, and so units get practice on all types of target which are likely to be met on service.

Conclusion.

In conclusion, I suggest that there was never a time when the Army thought so much about the future of warfare.

Modern scientific inventions have completely changed the aspect, and it is not easy to see through the fog, but I do think that there does appear, clearly, to be a great increase in the air menace.

Aeroplanes of all sorts are becoming steadily cheaper, more efficient and reliable.

I hope I have convinced you that we have a technical reply in the gun.

Unless, however, officers appreciate the developments of anti-aircraft, and know how to handle A.A. Units, we shall not obtain the great results which the technical developments will place within our reach.

A.A. gunnery is a science—and a new science—but it is not a mystery.

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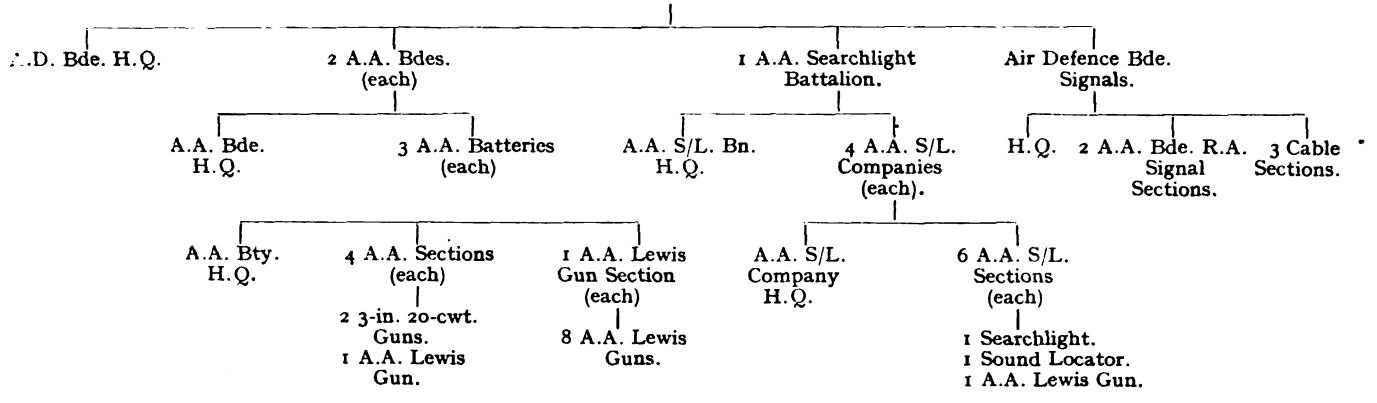
ANTI-AIRCRAFT GUNNERY.

TABLE GIVING COMPOSITION OF AIR DEFENCE BRIGADE.



TOTALS :—

3-inch 20-cwt. Guns	48	
A.A. Searchlights	96	
A.A. Sound Locators	96	
A.A. Lewis Guns :		
in A.A. Lewis Gun Sections	48	168
in 3-inch 20-cwt. Sections	24	
in A.A. Searchlight Sections	96	

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THE "MODERN" DIVISION.

By CAPTAIN G. S. HATTON, ROYAL ENGINEERS.

"There is these days a tendency to exaggerate the power of mechanized forces and correspondingly to belittle the action of other arms."

"If it were so, it was a grievous fault;
And grievously hath Cæsar answer'd it."
—*Julius Cæsar*, Act III, Scene II.

INTRODUCTION.

Before commencing any discussion relative to the employment of mechanized forces and other arms, it is essential to make quite sure what are mechanized forces. In order to clear up this point, the present writer has adopted two definitions employed by Major-General Sir J. Burnett-Stuart*:—

> "A mechanized unit or force is a unit or force whose capacity for fighting and movement is assessed entirely in terms of machines."
>
> "An unmechanized unit or force is one which fights and moves entirely in terms of man and horse."

Although, perhaps, a war waged entirely by mechanized forces will come some day, the present writer's idea of the next war of any magnitude, in which we are likely to be engaged, is one in which mechanized and other arms both take part. There may be A.F.V.s with the unmechanized forces; but just as the strength of a chain is the strength of its weakest link, so is the mobility of a force the mobility of its slowest unit. Hence the poignant division into "mechanized" and "unmechanized" forces laid down by definition.

GENERAL DISCUSSION.

The Mechanized Force.

It is necessary, now, to arrive at a clear understanding of the capabilities and limitations of a mechanized force, or, as it is now officially termed, "Armoured Force."† The recent experiments on Salisbury Plain were conducted with a force of 800 cross-country vehicles, of which 300 were fighting vehicles and the remainder auxiliary or maintenance vehicles. The organization and armament of a "future" mechanized force is shown in diagram 1. This has been deduced from the actual accomplishments

* "The Progress of Mechanization," *Army Quarterly*, April, 1928.

† Both terms are used synonymously in this article, since one is used in the quotation under discussion and the other is now the official designation.

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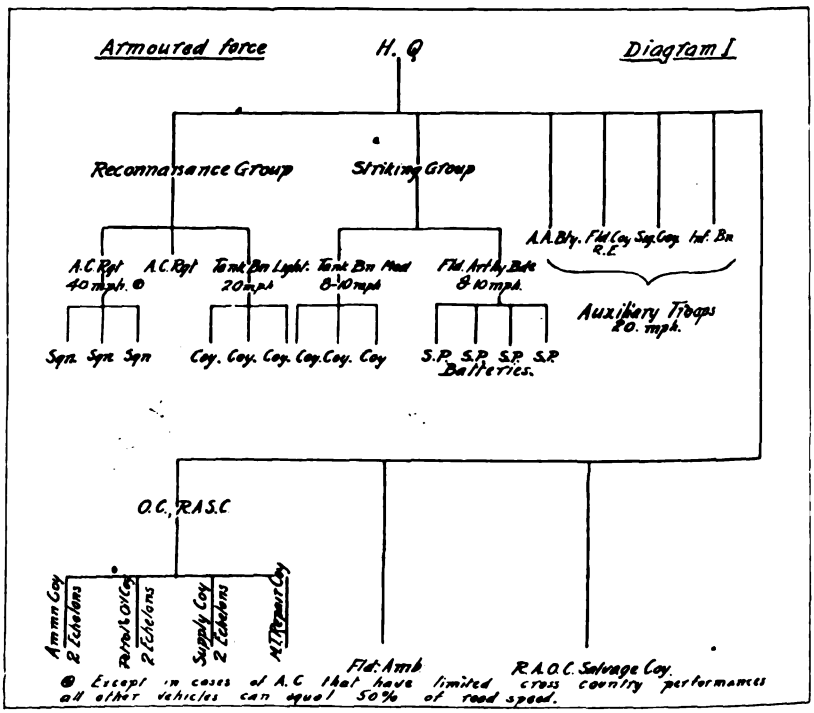
and needs of the Experimental Armoured Force in the light of experience gained. Such a force can march and fight for ten days without returning to its base, its radius of action being about 180 miles.

One of the great limitations of this force is imposed by obstacles; it cannot operate in rocky mountains, closely wooded or very broken country, and it is very sensitive to the dangers of defiles.

Napoleon, when speaking about military obstacles, placed them in the order: deserts, mountains and rivers, the latter being a bad third. Modern developments in engineering and other sciences have tended to overcome desert obstacles rather than mountains. In order to substantiate this statement, it is only necessary to compare


Armoured force
H. Q
Diagram I.
Reconnaissance Group
Striking Group
A.A. Bty. Fld Coy Sig Coy Inf. Bn R.E
A.C. Rgt 40 mph. @
A.C. Rgt
Tank Bn Light 20 mph
Tank Bn Med 8-10 mph
Fld. Artly Bde 8-10 mph.
Auxiliary Troops 20. mph.
Sqn. Sqn. Sqn
Coy. Coy. Coy. Coy. Coy. Coy
S.P. S.P. S.P. S.P. Batteries.
O.C., R.A.S.C.
Ammn Coy 2 Echelons
Petrol & Oil Coy 2 Echelons
Supply Coy 2 Echelons
M.T. Repair Coy
Fld. Amb
R.A.O.C. Salvage Coy.
@ Except in cases of A.C. that have limited cross country performances all other vehicles can equal 50% of road speed.

Allenby's campaign in Palestine and the less important but instructive dash of the Duke of Westminster's armoured cars to Solum, with Skeen's difficulties in Waziristan in 1919. Modern developments made the first two possible; in the latter case they were of little, if any, help.

With mechanized forces, mountains, as obstacles, will undoubtedly take pride of place, and thickly wooded country take on new importance. The decisive actions of the world have, however, never been fought on mountain tops nor in dense forests, and are not likely to be in future; although mountains and woods have been, and will again be used as pivots of manœuvre.

From the limits imposed by natural and artificial obstacles, our

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attention turns logically to questions of supply and maintenance. Its insatiable thirst for fuel prevents a mechanized force roaming far and wide indefinitely.* As diagram 1 shows, an armoured force is tied by its tail to railhead. The tail may be longer and less sensitive than that of an unarmoured force, but it is a very definite and sensitive tail.

An armoured force is, moreover, less liable to suffer gas casualties than its unmechanized rival. Although easily spotted from the air, in fine weather, once its general location is known, such a force is by no means easy to locate in an area represented by a semi-circle of radius 180 miles and uncertain centre.

From a consideration of the armament and capabilities as set out in the table of diagram 1, subject to the general limitations indicated above, it is possible to arrive at the proper rôle of such a mechanized force. The methods of employing it may be enumerated as under :—

(i) *Strategic Reconnaissance.* This was the true but very imperfectly performed rôle of Sordet's Cavalry Corps in 1914. Something more on the lines of Stuart's " Rides round the Federal Armies " is indicated.

(ii) *A wide turning movement, culminating in an attack on the flank of an enemy already engaged, i.e.*, a blow similar to that delivered by General Maunoury's Army from Paris against the German right in September, 1914, one however, more rapidly delivered, more intense in form, and capable of early repetition. " The Race to the Sea," 1914, would have given an armoured force a chance to show its real value.

(iii) *A special operation involving a long movement up to the limit of the force's capacity to maintain itself away from railhead.* A mission similar to that so successfully undertaken by Stonewall Jackson which culminated in the second battle of Manassas in 1862.

(iv) *Exploitation and pursuit.* As exemplified by General Allenby at Megiddo in 1918.

" Victory," said Napoleon, " is nothing ; one must exploit success ; " and again, " The secret of war is to march twelve leagues, fight a battle, and march twelve more in pursuit."

The devastating thing about a mechanized force is that it moves and fights at the same time, while unmechanized forces have to halt before fighting ; consequently initiative and surprise must tend to rest with the former.

The Other Arms.

There are other roles in war besides those for which a mechanical force is suitable. Even if it were desirable for tactical reasons to

* A march of 50 miles means the consumption of 40 tons of fuel and oil.

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mechanize the whole Imperial Army, there are certain difficulties and reasons why this could not be done. The consideration of these difficulties and reasons are outside the scope of this paper, but, as they establish the existence of unmechanized forces for years to come, the present writer proposes to enumerate the more important:—financial difficulties, dangers of too rapid transformation, difficulties of mobilization and training, difficulties of accommodation, difficulties presented by the Cardwell system, requirements of Empire internal security in tank-proof countries, imperfection in design, variations in climate, questions of policy *inter alia* with the Dominions and India.

Therefore the acid test to which "the other arms" must be put is "a war out in the open spaces," either allied with or opposed to such mechanized forces as we have been considering.*

The army to-day is in a state of flux, and its armament, organization and consequently training, alter yearly. These are questions that will be discussed later; but in fairness to the critics who display "a tendency to exaggerate the power of mechanized forces and to belittle the action of other arms," we must accept these other arms as being in the condition they were in when the criticism was made. In 1927, the condition of most units was that indicated in *Small War Establishments*, 1923. Let us accept this as our standard. (See diagram II.)

Having accepted this, and remembering the picture of a mechanical force drawn earlier in this article, one must at once confess to a personal sympathy with both the critics and "the other arms"; with the critics for the soundness of their reasoning, with the other arms for the inadequacy of their armament, organization and training. This, however is said in no carping spirit; steps are being taken to rectify their defects, and it is doubtful if their being taken earlier was either expedient or possible.

Keeping in mind Napoleon's statement that "The moral is to the material as three is to one," let us ask ourselves, "What of tanks in the last war?" "Locally decisive!" "What has been the great cry of all infantry and cavalry commanders since the War?" "Give us our own anti-tank weapon!" "Have they got it?" "On paper, yes; in practice, no!"

"A mechanized force can do little against troops in a defensive position, well chosen, with tank obstacles, anti-tank guns and mines properly co-ordinated, except keep them from moving." Don't we all know this position? Times without number, since the War, the writer has attended "Defence Schemes." Always there was a shortage of time to organize and prepare, a shortage that was nothing to the shortage of time that would exist in war. Always was the enemy coming from one direction. Never was there that

* The action of "Other Arms" against similar unmechanized forces, being less important, has been excluded from consideration by the limitation of the length of this article.

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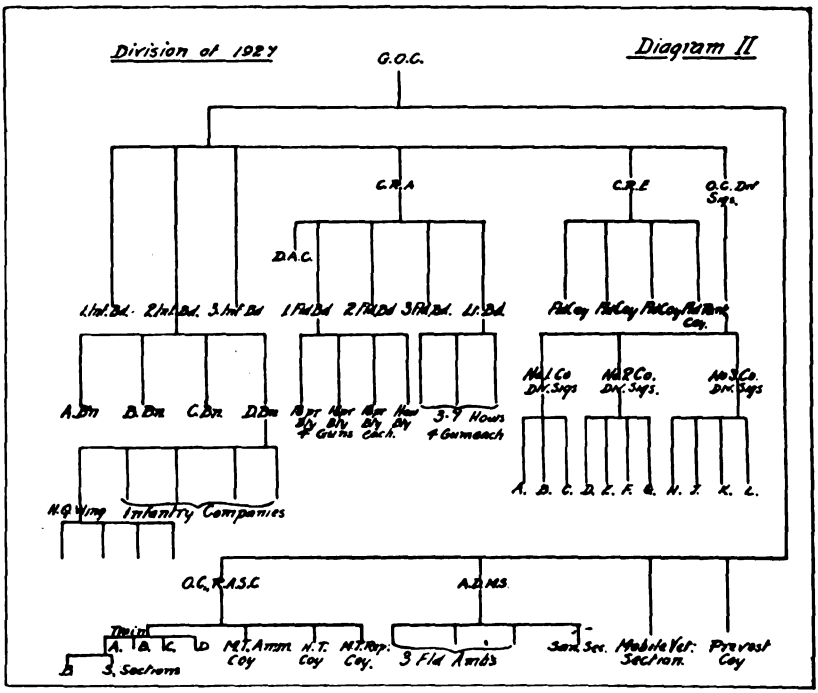

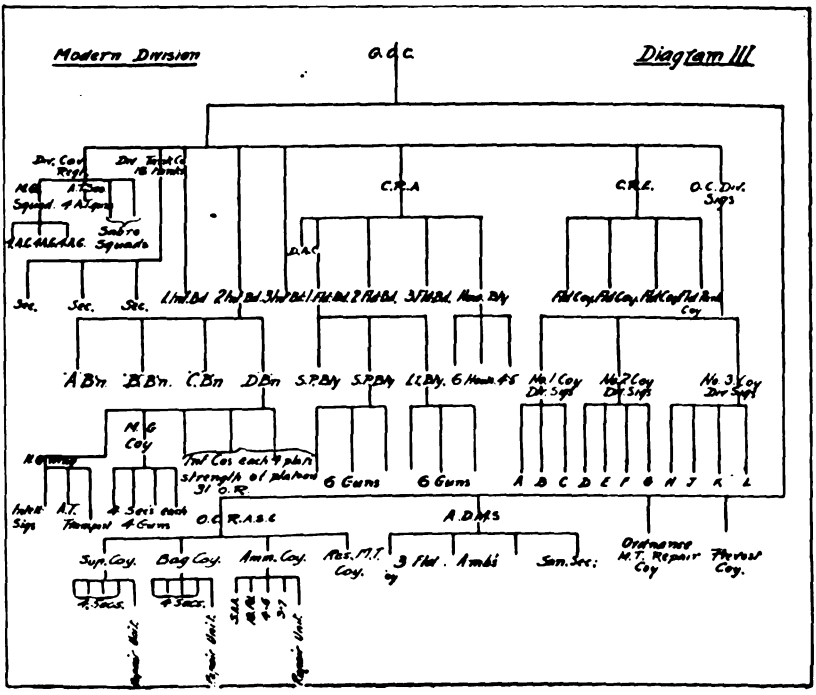

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idea of all-round defence that must henceforward permeate the mind of every commander. Always the demands for anti-tank guns exceeded what the C.R.A. could spare. Always the call on the sappers exceeded what could be done with the equipment and time available. And this is the unmechanized force at its safest!

"The security of a force and its communications is the first responsibility of a commander."* This principle applies equally on the move as when at rest; but the armament and training of our divisions to-day is not adequate to provide protection against mechanized forces, when the former are on the move. The commander requires early information and an all-round sense, yet an infantry division has no cavalry. In addition to the shortage of A/T weapons in a division, such weapons as there are are incapable of coming into action on the move. The same applies to A.A. weapons. The present ideas of a large percentage of officers, on the need and composition of flank, etc., guards, require revision in view of these new conditions. There is no reserve available in the hands of the divisional commander for counter-attacking a mechanized force; yet no one will dispute the supreme value of the immediate counter-attack in war. The present mixture of H.T. and M.T. in certain units practically renders tactical unity impossible on the move.

A force, however, must advance—its commander must think of his object or objective and not of anti-tank areas. "Victory can be won only as the result of offensive action."† Offensive action implies movement, and movement, as we have seen, at once reveals all the above defects in our existing organization. The moral effect of the mere presence of a mechanized force thus has a tendency to paralyse movement. Of the effect of an attack by mechanized troops against other arms we can gain some inkling from the operations on Salisbury Plain last year‡; the most devastating results were obtained by the mechanized force.§

Experimental Stage Passing.

The mechanized force or armoured force that exists to-day is an experimental or research organization.|| Until it is known what such a force can do, it is obviously inexpedient to equip other troops with an armament, organization or system of training to combat this new force. From this research organization we have already arrived at the capabilities and limitations of a mechanized force, as enumerated earlier in this article; now, from the same organization, we have enough information to enable us to forecast the armament, training, and organization of our other arms—the experimental armoured force has, so to speak, been working for both sides.

* *F.S.R.*, II, 2 (2) (vi).
† *F.S.R.*, II, 2 (2) (ii).
‡ Written in Summer of 1928.
§ See page 38, *Army Quarterly*, April, 1928.
|| Since this was written its existence has been temporarily suspended.

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Changes in Training and Armament Advocated.

General Difficulties in way of Mobilization—A Temporary Change of Policy Advocated.

There are certain difficulties in the way of modernizing an army. Capital is required for modernization and the army has only a small yearly income. The continuance of the Cardwell system or the introduction of an alternative system presents difficulties; other difficulties are questions of mobilization, accommodation and climate, regimental traditions and conservativeness. These difficulties become greater when we reflect that, in addition to the Regular Army, there are the Territorial Army and the armies of India and the various self-governing Dominions.

It therefore seems that we must make a temporary departure from the policy "that the organization, equipment and training of the various component parts of the Imperial Army shall follow a general standard common throughout the Empire."* and make a beginning with the Regular Army, including that part of the Regular Army that is in India.†

A return to this policy at an early date is desirable and the Territorial and Dominion Forces must, in time, be modernized at the expense of their size. The Indian Army is a different problem, as it exists for a special role.

Before building up the organization of the division, each arm must be considered separately.

Cavalry.

A regiment now consists of two sabre squadrons and one M.G. squadron, the latter being provided with six-wheel transport for its twelve M.G.s. These latter should be replaced by twelve armoured cars and a squadron leader's car (R/T)—more cars may be desirable, but are prohibited by expense. These cars should have the same cross-country mobility as the armoured cars of the mechanized force. In addition, there must be at least two anti-tank weapons‡ with the regiment. The writer feels that four are really needed; this allows of a sub-section accompanying each sabre squadron or of their being so placed as to protect the regiment as a whole. The A.C.s can, by their mobility, avoid tanks or draw them on to the anti-tank weapons of the regiment.

The load on the horse must be reduced to a minimum by mechan-

* *F.S.R.*, Vol. I, sec. 1 (3) (iv).

† Fortunately India has now accepted the principle of modernization.

‡ This weapon must be able to knock out a tank at between 600 yards and 100 yards with an angle of impact for the projectile exceeding 45°. It must be capable of all-round traverse, and of action while on the move. A weapon firing a 1-lb. shell, and answering to this specification, has been designed, together with a mechanically-propelled, lightly armoured vehicle, having a cross-country mobility of four miles per hour, and a road mobility of from two-and-a-half to ten miles per hour.

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ized transport—the latter to include R/T tender and office for C.O. The idea of shock tactics will have to go in the near future, and with it the sword. Although the role of cavalry divisions and armoured brigades are complementary, henceforth the duties of cavalry are reconnaissance duties; anything else recalls the field of Balaclava, *" C'est magnifique mais ce n'est pas la guerre."*

Artillery.

Even to-day, our medium and heavy artillery is mechanized to all intents and purposes, so is our anti-aircraft artillery. We may then leave these and turn our attention to the Field Artillery, which forms the bulk of the artillery of an army.

The superiority of mechanized over horse-drawn artillery on almost every type of ground—pack or mountain artillery having its own rôle—is generally admitted; these new machines are noisy, but it is a defect that can be modified, and the field of battle, even at night, is a noisy place where much passes unheard. The howitzers in a division, may be dragon-drawn, but for the 18-pdr., or the substitute,* which certain technical authorities demand, a S.P. mounting appears imperative.

Economy demands a reduction of personnel to find the funds for these new machines, and so the age-old controversy of six-gun or four-gun batteries should once and for all be terminated in the triumph of the former.

There remains the close-support weapon, the light artillery of to-day. A new mechanically-propelled weapon has been designed to replace the 3·5 howitzer. If we can have more guns in a division, then an eight-gun light battery is desirable; but, if not, and it seems unlikely, let us stick to our six-gun organization.

Engineers.

In no arm of the service has less been done to improve and modernize the transport and equipment since the War than in the Engineers. The truth is that sappers are expensive members of the military family; much that they need in war can, it is maintained, be obtained from civilian resources on mobilization; other parts of their equipment must be designed after the loads it will have to carry have been determined and, finally (and this is the main reason), in war the chief duty of the Engineers is to make conditions resemble manœuvres. Hence their duties and difficulties are not easily realized in peace.

* It is contended by certain authorities that the 18-pdr. is too large and heavy, too conspicuous, and fires an unnecessarily large shell—ammunition supply is a very large point—and that the lightest, fastest and most inconspicuous gun possible, firing a shell effective at 1,500 yards range, is needed. Against this the present writer maintains that modern Naval development shows the tendency of gun power to increase with armoured rivalry.

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In war, the R.E. unit must often be brought up from the rear to overcome an obstacle which holds up the advance. The day when the sapper can be allowed to walk and when hand tools, as a general method of work, are economic, is past. In future, a high proportion of engineers must be moved in cross-country carriers, their transport must be mechanically propelled and must contain mechanically-driven tools. Adequate bridging equipment (light bridge* to take six-wheelers and assault equipment) must accompany the Field Park Company and anti-tank mines and a considerable stock of explosive must be within easy reach of the Field Companies.

Infantry.

Let us accept the new battalion organization—three infantry companies, a machine-gun company of sixteen guns, and H.Q. wing. The M.G.s have cross-country transport but the present type of six-wheeler is not suitable, it is far too conspicuous; guns cannot be brought into action on the move, and have to be " man handled into action " for a considerable distance.† A new vehicle is required for the anti-tank gun, referred to earlier; the same vehicle can be adapted to take a M.G., together with its ammunition. This should enable the M.G. Company to protect the battalion, both on the move and at rest, from air or other sudden attack.

The infantry companies must be capable of " light action," often at the double—their duties will much resemble the " clouds of skirmishers " of the days of Wellington and later of the American Civil War; combined with a certain amount of " winkle-ing," or " mopping up." To perform these duties the load on the soldier must be further reduced; it is calculated that mechanization of transport, combined with a redistribution of loads, will relieve the soldier of at least 7 lb. Except when working detached, companies will have no vehicles, since hot meals can be sent up from the transport lines and the day of the Lewis gun is past. Pending the arming of the soldier with a true automatic rifle (of the Browning type), the number of M.G.s in a battalion will enable the present rifle to suffice. The vehicles of the battalion forming " B Echelon " will be manned by R.A.S.C. personnel under a senior N.C.O., with an R.A.S.C. officer as Brigade Transport Officer. A high proportion of both personnel and vehicles can also be obtained from civilian sources on mobilization by the proper utilization of the Supplementary Reserve and the subsidy scheme for M.T.

* A.C.s, tanks and S.P. artillery can, by their extra mobility, make detours and regain the division after it has crossed by a light bridge of this nature.

† A new design—see *R.U.S.I. Journal* of May, 1928—for sub-sect. of M.G.s only partly fulfils this requirement. Normally, neither the anti-tank weapon nor the M.G. will fire from their vehicle.

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The battalion must have its own anti-tank weapon; the same type referred to above is advocated. However many there are, they must be concentrated for training and administration—the writer prefers four as a group of the H.Q. wing.

These changes should enable the strength of a battalion to be reduced to about six hundred of all ranks.

THE MODERN DIVISION.

We have dealt in turn with each of the unmechanized arms and it now remains to build up the organization of the unmechanized division; this latter must include mechanized units and A.F.V.s, for security from attack by mechanized forces. "Whether tanks are held in rear or are made available for immediate counter-attack, it should be realized that they constitute the most valuable reserve in the hands of a commander for dealing with hostile tanks."* Of the other vehicles,† all second-line vehicles and "B Echelon" must have engines and chassis conforming to civilian practice in order to facilitate mobilization and to utilize the subsidy scheme. It is likely that this can be extended to include other vehicles, *e.g.*, R.E.

Reconnaissance Troops.

The provision of army co-operation squadrons on a basis of one per division, although actually Corps Troops, is ample. The need of cavalry is becoming more and more pressing; and in order to get that sympathy and understanding so essential to co-operation, the cavalry must be divisional and not Corps Troops. With armoured forces replacing the rôle previously carried out by large cavalry formations, a regiment per division is advocated.

Assault, Defence and Counter-attack Troops.

Tanks and infantry, with their M.G.s, are the chief means to these ends.

The principle that tanks, like other arms, must be concentrated to achieve their full effect, and the desirability of increasing, as far as possible, the number of armoured brigades (of which tanks form the basic element) prevent any great allotment of tanks to a division: but at least a company is necessary, if the "modern" division is to operate freely in a country in which mechanized forces are at large.

With the higher organization of infantry, *i.e.*, three brigades each of four battalions, there appears little scope for improvement, unless, which all of us deplore, further economies necessitate brigades of three battalions. It will, however, appear later when considering training that the Brigade Staff must be increased.

* *T. and A.C. Training*, Vol. II, Sec. 51 (8).
† Six-wheelers.

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Supporting Troops.

Exclusive of the M.G.s and anti-tank weapons included in the battalion, etc., organization, these consist of artillery, engineers and signals.

By a comparison with other European divisions, it appears that only in gun power is our division below the hitting power of those of other nations. It is unlikely that more guns per division will be forthcoming, and the organization advocated below is based on the assumption that with six-gun batteries the total number of guns in a division, exclusive of tanks and purely anti-tank artillery, remains at sixty. The divisional artillery might consist of three Field Brigades each of two S.P. batteries (18-pdr. type) and one mechanically-propelled light battery. The remaining battery, 4·5-in. howitzer, would occupy a position similar to that of the medium battery in the division of 1914. If more howitzers are required, and this is now being advocated in the Commands at home, this battery must become a Brigade. The C.R.A.'s staff might remain unaltered, and the saving in officers and other ranks—including those childless parents (once in action), the O.C. Light Brigade and his staff—would effect a considerable economy in personnel.

The number and general organization of Field and Field Park Companies requires no startling alteration other than mechanization of transport; but their equipment and tools require drastic revision and modernization as already explained. Signals are more up-to-date and require little improvement except in transport, and an increase in the number of D.R.s.

Administrative Services (with the exception of the Ordnance) have reached a stage in development, not only far ahead of other countries, but far in advance of the arms of the service which they exist to serve.

The introduction of mechanization and the almost synchronous transfer of mechanical maintenance to the already heavily-burdened ordnance is in danger of proving the last straw on the camel's back. If it is so, a dangerous state of affairs will arise for the Army as a whole—a state of affairs which is rendered no more hopeful by the camel having loaded itself.

Certain administrative units must be provided with mechanically-propelled cross-country vehicles, notably the D.A.C. and H.T. Company, R.A.S.C. The latter unit must be capable of " lifting " a battalion. The M.T. repair company must remain, but the R.A.O.C. also need such a unit; and certain of the latter's personnel must be attached to fighting units as artificers for first-line repair of " A Echelon " vehicles. The veterinary establishment can be reduced two officers per division.

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A comparison of the " Modern " and existing divisions is given in diagrams II and III, together with summaries of these changes in diagram IV.

Table of relative strength — *Diagram IV*

	Division 1926 27	Division Modern	Armd force
Ration Strength.	17. 385	12000	4000
Sabre & Bayonet strenght	5. 760	4000 auto rifles	400
Lewis guns	445	Nil x	Nil
Armoured cars	Nil	13	50
M. Guns } excluding tanks	96	196	16
A.T. guns } excluding tanks	Nil	52	4
Light tanks	Nil	Nil	32
Medium tanks	Nil	16	32
Guns & howitzers	60	60	24
A.A. weapons	116 L.G	196 M.G's some L.G.	8. A.A. guns
Vehicles Special	890	220	300
Vehicles Commercial type ...	370	700	500
Horses	5027	1500 ⊛	Nil.
Mobility	2½ mph	3 mph	8 mph
Normal daily rate of march	10 miles	15 miles	50 miles
Forced march	15 miles	20 miles	100 miles

x A few L.G's for A.A. defence might be kept by Engineer, Signal & R.A.S.C. units

⊛ Riding & pack animals only

Programme Recommended.

The changes advocated cannot be carried out completely even in one division in one year, let alone throughout the Army.

Let us suppose that it has been decided to modernize one division on the lines advocated; there may be, and most likely are, better ways of doing it (only those with complete inside information can decide), but this forms a good basis for discussion.

The selected division would complete its reorganization in three years, and subsequently would absorb three new battalions and one Field Brigade per year—the replaced modernized units going abroad. After three years, other divisions could be modernized much more rapidly owing to the experience gained and the fact that some gradual modernization of all units in accordance with this plan could have taken place *ad interim*.

Training.

Neither the introduction of armoured forces nor the modernization of unarmoured forces will alter the principles of war; but they will

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undoubtedly affect the application of these principles. The extension of the area over which operations may take place, the danger of attack from almost any point of the compass in addition to the air, introduces the need for all-round protection both at rest and on the move. The increased difficulties of command and control resulting from increased mobility will often necessitate the issuing of instructions as opposed to orders; hence the greatest initiative and a genuine knowledge of all arms will be required from subordinate officers. Commanders of units and formations in unmechanized forces as well as mechanized must learn to think in terms of a force moving at 10 miles per hour as opposed to 2½ miles per hour—no easy matter, and one which requires all commanders to make rapid decisions. The cavalryman must learn to read a map from his A.C. at 40 miles per hour. Opportunism will flourish and decentralization be the order of the day. Many actions must become automatic, resembling the almost subconscious actions of mountain warfare, but equally they must not become dogmatic routine.

The principle of concentration remains; but concentration must be consistent with effective control.

The presence of an armoured force will necessitate a " Modern " division on the march adopting a formation tending to resemble the " *Bataillons carrés* " devised by Napoleon during the period immediately preceding the battle of Jena, rendered necessary as he was very ignorant of the moves of the Prussians right up to and including the battle; a state of affairs likely to be reproduced due to the mobility of mechanized forces. This will reintroduce that bugbear, the " Brigade Group," which is disliked, as it is

(i) contrary to the accepted principle of concentration, and

(ii) too large a force of all arms for the present Brigade Staff.

With the reduction in the effective range of guns, due to the mobility of A.F.V.s, centralized control of artillery is not only unnecessary, but it is positively dangerous, except in defence or a deliberate attack.

" Control should be centralized in the highest formation, which can exercise it without risk of failure, and at the same time ensure co-operation in action between the units in the forward area."* The effect of these new conditions on the decentralization of engineer and medical units is not so pronounced, although detachments may be more common than in the past. The addition of one, or at most two staff officers, a clerk, and an office car, is all that is required to overcome the second difficulty.

With regard to individual training, the existing principles remain

* *F.S.R.*, Vol. II, 72 (5).

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sound. The annual change over of " Specialists " must be larger in future. All men after their second individual training season must become " specialists " ; their remaining individual training being devoted to making them, say, first machine-gunners and, later, drivers I.C. Men will thus pass to the reserve capable of taking one of many rôles in the battalion or other organization on mobilization.

It is, therefore, maintained that the Army shall continue to be trained on the lines indicated in *Training and Manœuvre Regulations*, and *F.S.R.*, Vol. II, as applicable to their new armament and organization, but that certain existing doctrines should be modified and others emphasized in the light of the above remarks.

CONCLUSION.

It may be argued that the changes recommended are too sweeping and impracticable. It is maintained, however, that the addition of 13 A.F.V.s for a cavalry regiment, together with four anti-tank guns and vehicles, the provision annually of two batteries of S.P. guns, one battery of light guns, and the mechanization of a field company's transport, are in the realm of practical politics. The vehicles at present intended for the M.G.s of the infantry can be adopted for their transport, leaving only the provision of 48 anti-tank guns, together with their vehicles and those for 192 M.G.s, to be provided in three years.

Exclusive of minor details, and measures already approved by the Army Council, the above is the programme recommended, and does not appear to the writer either impracticable or too sweeping, nor can it be contended that the acceptance of this programme, together with its resulting economies, exceeds the funds available. The transformation is not too rapid, nor do any of the likely theatres of war present an unsuitable terrain for such a force—Europe, even the Balkans, Asia Minor, Palestine, Egypt, Arabia, the greater part of Persia, India, Afghanistan (especially the southern area), the Sudan, present no unsurmountable obstacle to the " Modern " division, since man, horse and mechanical vehicle have each a high cross-country performance, while the conversion to a scale of equipment and transport suitable for mountain or forest warfare, though slow, would be as feasible a proposition for this force as for the present-day division. Neither the difficulties presented by variation of climate, nor by mobilization and sea transport, are greater than before, and the force would be as equally prepared for the passage of rivers or for amphibious warfare as is our present organization. Over and above this, the always present problem of Imperial internal security can more easily and economically be attained with the adoption of this modernization.

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Both at rest and on the move, this modern division would be equipped and could be trained and handled in such a manner " as to move and rest undisturbed " by the presence of mechanized or unmechanized forces of corresponding strength. " A force adequately protected retains its liberty of action and preserves its fighting efficiency for battle."* This protection would be afforded by the presence of cavalry, including A.C.s for reconnaissance, by the ability of its A/T and A.A. weapons and M.G.s to move and fight at the same time, by the existence of a mobile reserve of tanks and S.P. artillery capable of executing an immediate counter-attack against tanks or other A.F.V.s, moreover, by the homogeneity of its organization, tactical unity on the march can be preserved and mobility increased. All these improvements, combined with the improvements in training and leadership developed by decentralization, will, in the opinion of the writer, produce in the form of this modern division a fighting formation far superior to that of the present time in operations against both mechanized and unmechanized forces.

The answer to the tendency to exaggerate the powers of mechanized forces and to belittle the action of the other arms is to modernize these other arms. The moral effect so produced will be three times the material improvement.

* *F.S.R.*, II, Sec. 2 (2) (vi).

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TEMPORARY ELECTRIC LIGHT AND POWER AT CHANGI.

By LIEUT. W. M. BLAGDEN, R.E.

FOR the benefit of those to whom the name " Changi " has no particular significance, it must be explained that the Island of Singapore has the shape of a very rough diamond—after the fashion of the Isle of Wight—and that on the eastern corner—near Bembridge, as it were—is Changi, the place selected for the site of the Army Base.

This is an isolated spot, connected to the town of Singapore—at Ventnor—by 16 miles of tortuous road, the convolutions of which would break the back of a proverbial serpent. The Naval Base, of which one reads so much in Promotion Examination and other papers, is at Seletar—Cowes—while the Air Base lies between.

When the band of pioneers first descended upon the jungles of Changi with the object of building a cantonment, one of the first undertakings was the purchase of what was then called " Fairy Point Bungalow." This was a weatherbeaten wooden structure, but it made quite a good officers' mess, and it came to us complete with a minute electric light installation—a " Delco " plant and battery. This was the origin of electric light in Changi cantonment.

When the temporary hutments for W.O.s and men had been erected in the vicinity, the benefit of civilization was extended to them by means of bare wires supported on insulators secured to rubber trees, of which there was any number. The distance was 100 yards, the pressure 32 volts, and the drop considerable. As the staff increased, the set became loaded much in excess of its powers, and a further supply was sought for. The only set that Singapore could produce out of hand—and that had to be sent down from Kuala Lumpur—was a 4½-kw. G.E.C.-Petter hot bulb two-stroke set, 110 volts unfortunately, but as beggars we had no choice, and it was hired and installed in a small and hideous hut at the cross-roads pathetically referred to as " Charing Cross." This was in point of fact the only place to put it, as the country further afield was as yet impenetrable. It took over the Fairy Point load and proved extremely reliable. Fairy Point Bungalow was turned into a quarter for the Chief Engineer, and the officers' mess was moved to a building nearly half a mile away, the Delco set being moved with it.

In the meantime it should be understood that, pending the development of the permanent 3-phase A.C. 400/230v. supply, a scheme had

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been evolved at the War Office for a temporary D.C. supply, of a fairly elaborate nature. Three 10-kw. Bellis and Morcom 220v. sets were prepared for shipment to Changi, and we were expecting them.

By the beginning of May, four Group IV married officers' quarters had been completed and were on the point of being occupied. It was clear that the load would be too much for the 4½-kw. set. At this juncture, we took delivery from home of two 3-kw. Petter two-stroke sets, 220v., which had been sent out for casual use on the various islands as they might be needed. They were well suited for this, but not for continuous night-after-night running, yet our only resource was to put them in to take the load at Changi, until such time as the proper sets arrived. The mechanist who unpacked them groaned. Even so, he did not know what was coming to him. The sets were of the magneto-ignition variety, petrol-starting and paraffin running, and they appeared to be reconditioned war stock. There was, however, no alternative. Even if the Fairy Point load could be kept low enough for the 4½-kw. set, it was fast becoming necessary to get the officers' mess on to the main supply, owing to the decrepitude of the Delco set and battery. The battery had been partially replated, but this was a failure: lead batteries do not seem to do well in the tropics at any time, on account of the temperature. This one was normally charged at 30 amperes, which was just about four times as much as its plates were fit for, and the paste soon poured out of the new plates as it already had out of the old. The engine did remarkably well considering the hard usage to which it was subjected, it did not overheat although it was air-cooled, and the air in the engine hut at about 90° F. But when the battery got to such a state that it would run itself out on no load, and not retain enough to start the engine next day, and when the engine itself had to be decarbonized twice a month to keep it running at all, it became clear that the set was giving more trouble than it was worth.

It was decided to instal the two 3-kw. Petter sets at once, and to let them take the load of three of the new houses, and of the Officers' Mess as soon as a line could be put up to feed it. This enabled us to buy 230v. lamps for the new houses, which would be suitable for the permanent supply and which were readily obtainable in Singapore. The 4½-kw. set was to continue on its usual load with one of the new married quarters instead of Fairy Point Bungalow, which was pulled down to make room for a permanent building.

A new power station was sited at the cross-roads marked X on the accompanying plan. This rather remote spot was chosen because it was suspected that the 3-kw. sets would be noisy (they were), and because it was more suitable for supplying the Officers' Mess. The hut was designed by the Machinery Mechanist, and therefore was a collapsible, extensible affair that was put together with a spanner.

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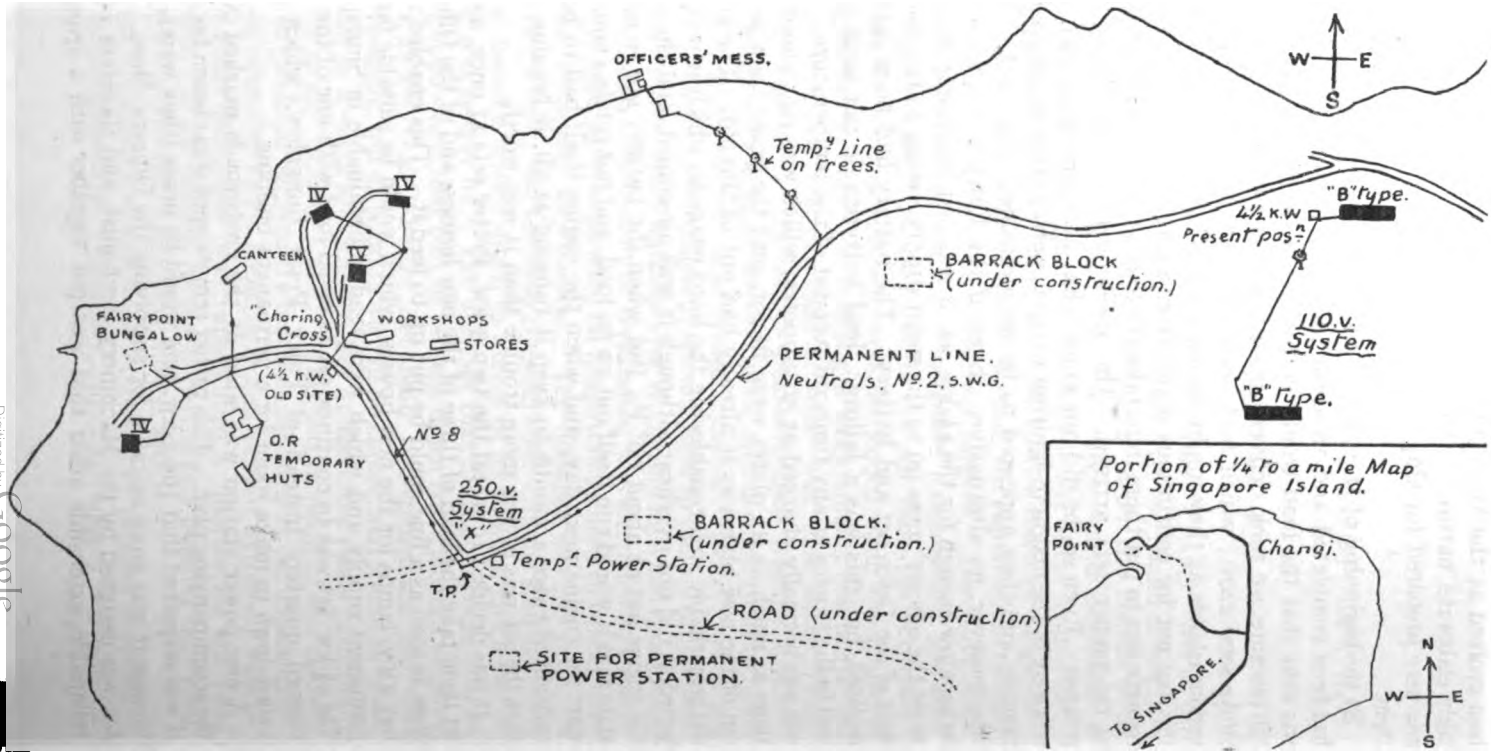
CHANGI: PLAN OF TEMPORARY E.L. SYSTEM.

Permanent Buildings solid black.



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It amused the M.F.W.s very much. Being intended to be used for a few months only, it will have seen over a year's service by the time it is superseded.

The terminal pole of the permanent overhead line happened to come at these cross-roads, so it was erected forthwith, and a power line was run down the road to the old hut at Charing Cross, where it linked on to the existing Fairy Point network. It was hoped that this line would become part of the permanent three-phase line, and so it was put on permanent poles, two-phase wires being put up at first.

It was not long before troubles started. The two 3-kw. sets seemed to be in reasonable running order on their arrival, and started up readily enough when installed, but they made their drawbacks clear from the very first.

They governed very badly under all loads, alone or in parallel, the governor gear being positively catastrophic in its action, and causing the engine to cut out completely until it had slowed down almost to stopping point. Just when one had given up hope of its ever firing again, there would be a shattering explosion, and it would laboriously pick up speed. A perfectly good tyre pump was sacrificed to make a pair of oil dashpots to mitigate this effect, but it made very little difference.

The generators were compound-wound with a very low resistance series winding, and naturally were fitted with an equalizer connection and switch. Nevertheless, the resistance of the switch contacts was sufficient on several occasions to allow the field of the generator that was being taken off the bars to become reversed, so that next night it built up on opposite polarity, to the great astonishment of the operator who tried to parallel it in. When this was discovered, the switch was omitted, and the brushes on the side of the series field of each machine were connected solid, so that the trouble did not recur.

The brushes were often seized with the complaint that overtakes all brushes in this country, unless they are specially made to avoid it: they unanimously swelled owing to the humidity, so that they bound themselves solid in the holders, having sometimes to be chipped out with a chisel. The symptoms of this kind of trouble are a refusal to excite or excessive sparking. The cure is emery-paper.

The armature end connections persistently unsweated themselves from the commutator riser bars.

The magnetos developed all the faults to which magnetos are prone in tropical countries, together with some additional ones occasioned by old age.

A time came when it seemed that a state of equilibrium had been arrived at between man and machine. Each set ran for the whole lighting period, 6.15 p.m. to 11.30 p.m., on alternate nights, the set that was resting being put on at the peak. The light was reasonably

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good. Then, after perhaps a fortnight of respite, the main bearings of No. 2 set ran out in a grand splash of white metal, and the remnants were taken into the workshops for repair. It happened that the lathe and a few small machine tools had just been installed in a very temporary workshop hut, and provided with some second-hand D.C. motors. The remaining engine, therefore, was made to run by day as well as by night, while new bearings were cast and turned, and the crankshaft was machined into something approaching circularity. For a time, it was questionable whether the additional wear and tear that resulted from using the electric light plant to drive the workshops was not greater than the workshops could repair in the time, but after a while it appeared that we were holding our own. Meantime, the population was urged to be economical of light, and the peak was kept down within the limits of the capacity of one machine.

On one hot and sticky night, when No. 2 set was still in pieces, the generator of No. 1 set was observed to be giving a very poor voltage, and its commutator was flashing like a veritable catherine wheel. It was clear that a coil or two had burnt out, so while warning was sent round of an impending blackout, of estimated duration half an hour, the generator of No. 2 was uncoupled and manhandled to an " alert " position. Then on a given signal No. 1 was shut down, and by the rays of a candle and a moribund electric torch, the two generators were changed over, and the undamaged one was coupled up to the relatively sound engine, which, thanks to mass production, it mercifully fitted. The operation took 35 minutes, after which the light was switched on again. The burnt out armature was rewound by a firm in Singapore, and a very good job was made of it.

The next thing to go was the engine of No. 1, whose main bearings became too loose to be trusted, and were renewed. The lubrication to the main bearings of both machines was by grease cups. It is extremely doubtful if any grease is suitable for lubricating a high-speed white metal bearing, it is quite certain that " grease, lubricating, for hot climates," which contains graphite, is utterly ruinous in its effect. The journals were badly worn and scored. After this, motor-car grease was specially purchased, which has given better results.

The foregoing is but a sample of the trouble given by these machines. They never managed to develop the full 3 kw. of their rating. An interesting feature of their performance was the fact that, when running on their full capacity, a better voltage could be obtained with a weak field than with a strong one, owing to the fact that by decreasing the torque resistance of the armature one gave the engine a chance to run at a higher speed, at which it happened to develop more B.H.P.

The instruments that came with the sets were even more decayed than the machines, and all ceased to function intelligibly after a

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short time, being replaced by local purchases. Even the field rheostats behaved oddly. One morning, when a set was being run to supply the workshops, it was observed that on putting resistance into the generator field, the latter became disconnected on a certain stud of the rheostat owing to a break in one of the resistance coils. The voltage quickly dropped off, and the rheostat control was moved back again to re-make the field. When this was done, however, the set built up again on opposite polarity, and the connections of the moving coil voltmeter had to be reversed to get a reading. This was a portent which could be repeated indefinitely, and, after reversing the machine back and forth until all record of the number of reversals was lost, we arrived at the explanation. This was the fact that the largest motor in the workshops had its starter handle tied up on account of a defect in the no-volt release coil. When the generator voltage collapsed owing to the breakage of the shunt field, the still rotating motor returned current into the line, and so through the series field of the generator in the wrong direction, thus reversing the residual magnetism, and causing it to excite in the opposite sense when the shunt circuit was remade.

At this time, there were three separate systems in the cantonment at different voltages, and it was decided to connect the Officers' Mess to the 230-volt supply. (We called it 230 volts by courtesy, actually it rarely exceeded 200.) The distance being about 600 yards, it was felt wasteful to put up a temporary line, so the permanent poles were put in for the line down the road, and the size of conductor required for the permanent distributor was roughly calculated. This came out at a size unobtainable at Singapore, but the two neutrals could be made of No. 2 S.W.G., which was stocked by several firms at a very reasonable price. This was bought and duly put up. It proved much more tractable than it looked, and was very easily pulled up with tensioning clamps which we cast in the brassfoundry. The Mess was about 200 yards from the nearest point on the road, but a strictly temporary line of No. 8 was run from that point on palm trees, which are very suited to this sort of thing, as they all bend the same way at the same time, and it is only necessary to allow the line to zigzag a trifle to make it perfectly safe.

We were about approaching the season of the year when a peculiar kind of storm called a "Sumatra" began to be prevalent. This blows up without warning at any time of the day or night, 4.0 a.m. preferred, usually from the S.W., and its onset is such that a dead calm can give place to a full gale within a minute. It may be mentioned in parenthesis that the salving of capsized yachts is a matter of routine organization in the local yacht club races. In the course of clearing sites for roads and buildings, it often happened that jungle trees were left in isolated positions. These, deprived of the support of their fellows, were readily blown over in *sumatras*, and, as often as

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not, across the overhead line. As they were apt to be about 150 feet high, the damage done was considerable, especially with the No. 2 conductor, which did not yield until it had wrecked the terminal pole.

It was accordingly decided to cut down all trees that could reach the overhead line in falling, *i.e.*, within 50 yards of the road, and a Chinese contractor was invited to carry out the work. This was a mistake. It is here that a Chinese method of cutting down trees must be explained. This consists in cutting away the wood impartially all round the base of the tree, leaving it supported by a stump of a few inches in diameter. The workman then withdraws himself to a safe distance, and waits for a puff of wind to complete his task, thus avoiding the moral responsibility for the demise of the tree, and any consequent annoyance from evil spirits. As the direction of the wind is at all times uncertain, so is the direction in which the tree will fall. If the tree is still standing by knocking-off time, he leaves it. Some hours later, an unsuspecting person taking a walk may be surprised by a large tree falling within a few inches of his head.

In these circumstances it is not to be wondered at that, out of a dozen trees that damaged the line, only four were blown over by tempests. The Chinese, however, soon discovered that it is better to incur the animosity of a tree demon than to meet a mechanist electrician whose line you have just wrecked, and more supervision was given and care taken.

In spite of these mishaps, no discontinuity occurred, as it was always found possible to run a length of "Maconite" cable in the ditch. It is felt that a good word should be said of "Maconite," which, though it was not suitable for permanent installation on account of its grading, and the necessity of using junction boxes which it entails, was freely employed on temporary internal wiring, for services to buildings on catenary wires, and for repairing gaps everywhere. It was even lent to Signals, whose lines also got knocked down by trees. There was a prodigious quantity of it available in store, and it was a godsend. One length of about 200 yards lay in a very wet ditch, and bridged a gap in the overhead line for over a month without giving the least trouble.

Throughout this period of trial, the arrival of the 10-kw. sets was hoped for and expected from day to day, but eventually it became known that they had been destroyed by fire on board the s.s. *Carmarthenshire* off Erith, and we were asked to carry on as best we might for six months, when it was anticipated that plant could be sent out to us.

The 4½-kw. set, which had behaved admirably throughout, was accordingly purchased outright for its original price less the sum already paid for hire, and a search was made in Singapore for further plant.

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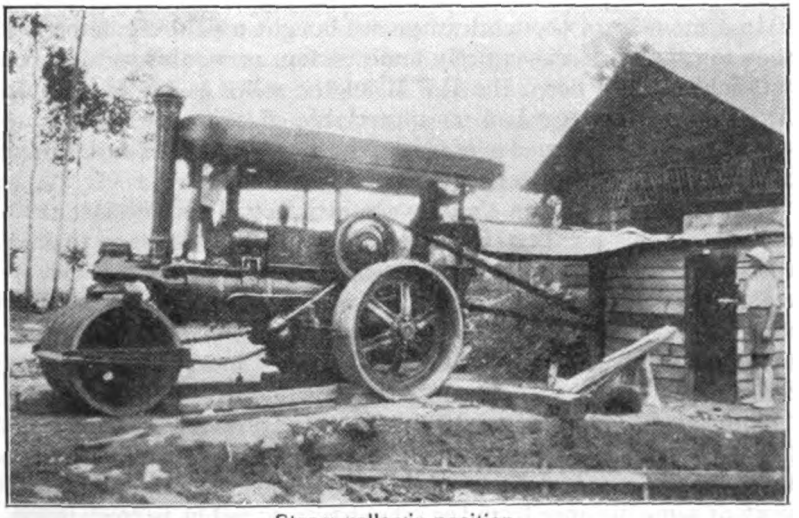
No 230-volt generating sets were available *ex* stock, nor was there at the time a suitable engine to be found. It was therefore resolved to use a steam roller as a prime mover, and look around for a D.C. generator of about 10 kw. at the correct voltage. The electrical department of the Municipality had an antique balancer set, 10 kw. a side, that they were anxious to get rid of, having changed over to A.C. It consisted of two 250v. generators coupled together. They had been built in 1905, and were of very robust construction. They were described as being in good condition, and the price asked was $100, about £12, provided we took them both away. We only wanted one at the time, but it was decided to take the pair and use



Steam roller in position.

one as spare to the other. A lot of brush gear was missing, but there was enough between the two to make up a complete set for one. The machine that gave the best i.r. test, and that a low one, was put in order, fitted with a pulley of suitable dimensions, and driven off the flywheel of the steam roller by means of a belt through the power-house wall. To produce the required voltage the roller had to do about 200 R.P.M., the pulley being the smallest that we dared put on. This was not too fast. It easily took the load of the whole of Fairy Point, which was changed over to 230v. throughout. Chocks were fitted in the ground where the roller stood, and after completing its day's work on the roads it was backed into position, coupled up, and handed over in steam to the night driver specially engaged for the purpose. This man, who had described himself as an engine driver, steam, was a Tamil, and extremely nervous. He explained that, though he was a steam driver, he really had more talent for internal-combustion engines. A voltmeter was fitted up in the cab, together

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with a lamp, the installation being connected with the power house by a wall-plug socket that received a wandering lead. The driver was bidden to keep the volts at 250 and the lamp steady. There was no governor on the roller, but it was surprisingly easy to keep the voltage constant by hand regulation. The engine could run for half an hour at a time without the throttle being touched. After a while the driver became bolder, and the light was perfectly good, except when the belt broke, or slipped in rain squalls.

The day driver became astonishingly adept in backing up into the correct alignment, and this was further facilitated by running with a crossed belt, which also gave the best results from the point of view of flicker.

In a moment of thoughtlessness we bought a field regulator, but soon found that it was entirely unnecessary, as we always wanted a full field to keep down the R.P.M. of the roller as far as possible. Altering the regulator had no appreciable effect on the voltage, as the engine merely turned over faster, the same amount of steam being admitted to the cylinders for a less torque resistance.

This arrangement has given every satisfaction for the last three months. The 3-kw. Petter sets are still used in the day time to drive the workshops, the 4½-kw. set was moved over to the two newly-erected blocks of " B " type married soldiers' quarters, where it still runs on a load of 4 kw. The roller rolled by day and illuminated by night, making the power house look like a merry-go-round at a country fair.

After about two months of this peaceful *ménage*, the news of a further delay in the anticipated delivery of the permanent plant from England, and the fact that the roller was shortly to be required to work at some distance from the cross-roads, urged us to fresh invention. The remaining 10-kw. generator was accordingly dug out of store and the missing parts of the brush gear were replaced by parts made in the workshops. An extensive search was made in Singapore for an engine of the lorry type.

Eventually we discovered a machine designed for the driving of barges by means of an outboard propeller. The engine was a 25 H.P. marine Peerless, with petrol and paraffin carburettors, 24-volt dynamo, self-starter and battery, fuel tanks, and sightfeed lubricating gear. It had never been used, having been imported for a speculator who went bankrupt, and it was in very good condition. The price asked was $700, including all the gear, which had to be taken as well. This was amazingly cheap for a new engine, let alone the propelling gear, and the offer was accepted and the set purchased.

A heavy timber frame was made to take engine and dynamo, which were direct coupled, the original flanged coupling of the balancer set being converted into a flexible one on the lines of a Hardy disc. There being no radiator, a 200-gallon tank was fixed up outside the

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engine room with a kind of cooling tower of wooden planks on top—the fitter made it up out of his head as he went along—and the water was circulated by means of the pump on the engine. The exhaust was led into a hole in the ground, which was filled with broken brick and provided with a drain. This made a fairly effective silencer.

The set was soon run up, and, after a few minor excitation troubles, was put on load. The light was excellent, being very steady without any governor. The R.P.M. required for 240 volts was 960, which was not too much, except for the Tamil driver, who was petrified and explained that he was much better with steam engines. The first few nights were made eventful by this man, who shut down the Peerless after the first half hour that he was left alone with it, and started the roller, which was standing by under steam. He said that a big end was knocking, and had to be dragged back to have it explained to him that the noise he had heard was due to the valves in the water pump. He then developed an abominable habit of opening the compression taps every quarter of an hour or so, to let out the devils. This appears to be a common precaution in this part of the world, and it is very productive of sooted plugs.

The set has now settled down to routine conditions, and it is hoped that it will be the last temporary expedient that will be required The steam roller still does emergency duty during periods of overhaul, or on those occasions when the persons whose business it is to attend to these things forget to send us the paraffin that we have ordered.

It is expected that the load on the Peerless set will be well up to 10 kw. by the time that the permanent installation is running, and the married soldiers' quarters will have to be kept on the 110v. supply till that time. This is no great inconvenience, as there is a sufficient number of 110v. lamps available without buying any more, and a 230v. fan gives quite a pleasant breeze at the lower voltage.

The network is slowly being converted to 3-phase, and the voltage drop is being reduced by turning a 4-wire system into two parallel circuits, for the time being.

At this point the reader, if any, may ask himself that question which is apt to creep into the mind at the end of a Tactical Exercise : " Well, what is this all for, anyway ? " On those solemn occasions it is usual to summarize the lessons learnt during the day, and it is proposed here to state what we ourselves have gathered from this variety of experience. Many of our conclusions will be obvious, some well known, but we will be modest and include them all.

1. Lead batteries are unsuitable for the tropics.

2. Armature insulation must be very good to stand up to Singapore conditions. Mica is best, and impregnation should be very thorough. Insulation resistance test is apt to be misleading. The balancer generators which are perfectly trustworthy

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gave 100,000 ohms only, whereas a small second-hand motor purchased for the forge blower gave 3 megohms and burnt out in a fortnight.

3. Brushes should be specified to be dense and non-hygroscopic. But it is better to avoid them altogether if possible. Small springs should be of phosphor bronze.
4. Magnetos are very troublesome here. The fibre insulation cracks easily, especially in the insulating flanges of sliprings. If the armature windings are made up with a lot of shellac, it will ultimately become soggy and soft, and fly out into the bearings, with devastating results. Magnetos, if not run once a week, should be stored in a dry place and aired at regular intervals.
5. Grease is unsatisfactory for lubricating high-speed white metal bearings, especially "Grease, lubricating, for hot climates," when used in hot climates.
6. Small sets can run quite safely without governors on a lighting load. Very little hand adjustment is required.
7. Such hand-governed sets need no field regulators.
8. Jungle trees in isolated positions are not to be trusted, however picturesque they may be.
9. T.R.S. cable laid just as it is on the ground, will carry a 230v. supply for a long time without failure.

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NOTES ON PORTABLE MACHINERY IN THE FIELD.

By LIEUT. E. BADER, R.E.

DURING the summer of 1928, the 55th and 59th (Field) Companies, R.E., were engaged in the construction of two rifle ranges on Bellerby Moor, about 10 miles from Catterick. A certain amount of portable machinery, including an excavator, was used on this work, and some notes on its performance may be interesting to other units using machinery under similar conditions in future.

The machines were installed, run and maintained in the Field for six months by the Sappers, with no workshop facilities nearer than Catterick. Under these conditions, we were well able to appreciate the need for the various accessories usually found in a workshop, and a list of the most useful of these is given at Table V. The following were the machines used :—

(1) *List of Machinery, Bellerby Ranges*, 1928.

Plant.	*Maker.*	*Weight each.*
Two stone crushers, 16 in. x 9 in. jaws, " Kibbling " motion.	Mason Bros., Leicester.	6 tons.
One portable loco type steam engine, 5 H.P.	Ruston.	6 tons.
One portable paraffin engine, 7 H.P.	Blackstone.	2 tons.
One capstan winch, driven by petrol engine, 4 H.P.	Bamford.	¾ ton.
Two portable concrete mixers, 1/3 cub. yd., with 1½ H.P. Lister petrol engine.	Parker's " Little Giant."	11 cwt.
One No. 4 excavator on caterpillar tracks, 40 H.P. Dorman engine.	Ruston & Hornsby.	15 tons.

In addition to the above, two balloon winches were supplied for hauling trucks, but they were defective and unsuitable, so were never used.

(2) *Stone Crushers.*

The site chosen for each of these was in a shallow cut near the top of a sloping hillside. A foundation of five sleepers laid crosswise below the wheels and dogged, carried 9 in. x 3 in. wheel-bearers, and

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was fixed in place on the clayey subsoil by means of 2 ft. 6 in. pickets driven flush. The crusher was then pulled into place with a traction engine and chocked up.

A corrugated-iron shoot about 20 ft. long was laid to a platform from which the crushed stone could be shovelled direct into trucks below. This arrangement necessitated a shovelling party of five men to remove the crushed stone from machine to trucks. To arrange direct delivery would have needed an elevator belt and gear, or a foundation under the crusher strong enough to allow a deep excavation to be made immediately behind it for trucks. But stores were not available, and the time and expense necessary for such work were not considered justified. To have undercut the hillside to give a slope of 1 in 1 to the iron shoot, without such foundations, would have endangered the stability of the crusher, a very "live" vibrating load of six tons.

The engine was next brought into place and lined up, a 65 ft. x 5 in. 5-ply Balata belt being fitted. The speed of the crusher was 250 r.p.m., and considerable trouble was caused at first by vibration. The crusher rapidly shook itself out of line, and had to be jacked back into place, a laborious process. This trouble was overcome by a design of braced chock, whereby the wheels rested entirely upon the chocks. A piped water supply was laid on for the steam engine.

A working party of one N.C.O. and seven Sappers, with ten infantry diggers, installed the two crushers, including shoots, in six days. Stone was brought by Decauville from various walls in the neighbourhood. It was a tough limestone, breaking sharp, with only a moderate amount of dust. This material was used unscreened, being mixed with cement and sand in the ratio of 1–2–5 approximately. It was crushed to 2½ in. ring, suitable for 9-in. walls or over.

The steam engine was suitable for this load, although rated at only 5 H.P. and working at 45-lb. pressure. The 7 H.P. Blackstone, however, proved too small, and laboured heavily. See also the Maintenance Table, No. IV. The output, hours worked and the running details of the two stone crushers are given in Table I. About 900 tons of stone were crushed and incorporated in the works (abutment walls and target sheds).

(3) *Capstan Winch.*

This replaced the defective balloon winches, and consisted of a 4 H.P. Bamford petrol engine and winch mounted on wooden bearers and driving through single reduction gearing. The winch carried a capstan head of the usual coned type to be found on ships' winches. A 3-in. fall was used, and 1-ton trucks were drawn up a slope of 1 in 8 by taking a few turns round the capstan and pulling the running end taut. About 200 tons of stone were raised without any trouble.

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The engine was somewhat crude, with an automatic inlet valve and grease-lubricated big end, but was very economical and strong enough for the work. An improvement could be made by mounting the engine and winch on a more solid bedplate. Incidentally, this plant would be eminently suitable for pile driving.

(4) *Concrete Mixers.*

These were one-third cub. yd. capacity, giving an output of 15 tons per day. The hopper-cooled 1½ H.P. Lister engine overheated and needed decarbonizing after two months' use, but gave no other trouble. The pivot bearing of one of the mixer hoppers was broken. The machines were mounted in G.S. wagons, in which they were conveniently moved about from place to place. This method also gave most of the height required for pouring concrete direct.

(5) *Excavator.*

Ruston No. 4 crane navvy, on caterpillar tracks (see Photo 1).

This machine was de-trained at Leyburn Station on June 25th. This was done by driving it from the truck under its own power on to a pile of sleepers. It then traversed the distance of two miles to the camp in six hours, including a steep hill out of Leyburn. A balance weight of one ton, and 30 cwt. of pig-iron ballast, were fitted on site, and digging started on the 27th.

Two days were then lost owing to rain, but by July 2nd Sapper Young had mastered the controls, and in the next three months the machine excavated 6,200 tons of stiff boulder clay and " limestone toppings " without serious trouble or mishap, except the failure on September 14th of the main engine clutch-thrust mechanism. This was replaced in the week-end, the firm having delivered the parts necessary in a few hours in response to a telephone call.

Table II gives the working results. The average rate of excavation was 21 tons per working hour. The limiting factors were the speed with which earth could be disposed of in trucks, and the smallness in most cases of the working face, necessitating many forward moves.

The machine was normally supported on sleepers laid crosswise when digging, but on the hard ground a few stones sufficed. It was driven up a slope of 1 in 7, down one of 1 in 4, negotiated the side of a hill sloping at about 1 in 10, and travelled twelve miles by road under its own power, averaging the not excessive speed of two and a half hours per mile !

The system of removing the excavated earth had to serve an infantry party digging in the same area as the machine and using the same Decauville Railway (see Photo 2). In the first stage, earth excavated behind the stop-butts was dumped on the 100 yards firing point, which was an eleven-foot bank requiring a large amount of earth. Trucks travelled in a circular route, later changed to out-and-return

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double track and sidings, according to the alteration in levels. All trucks were pushed by hand, three men being required for each one-ton truck. There were thirteen trucks available, and at one time the output reached 250 trucks per six-hour day on a round trip of 450 yards, or an average of 42 per hour and 20 minutes per round trip for each truck, including filling. Of this total the excavator accounted for 150 to 180 trucks.

The best method of dumping earth from a truck was the use of piers consisting of 60-lb. rails supported over the proposed bank on baulks. The truck was run out on a light rail lashed above these rails, and tipped sideways. Three such piers were needed to cope with the output, two being in use whilst the third was moved forward. The 9-lb. Decauville used was too light for one-ton trucks on soft ground, and a maintenance party was continuously employed keeping it in repair. But it had the advantage of being easily bent by hand to curves as required.

The next stage was to move the digger to the stop-butt bank, where it dug earth from a borrow pit and discharged it direct without the use of trucks. Owing to the volumes and heights and the limited radius of the bucket-jib, this system was quicker than the use of trucks only when the bank remained below 4 ft. 6 in. Above this height it became necessary to discharge into trucks.

In the final stage, some shallow digging remained to be done, when all exits for Decauville track had been closed. The digger was used to tear up the earth and deposit it in loose heaps which were removed in barrows. In this case the digger working half-time kept 25 barrows in action on a 70 yard round trip; 15 shovellers were required. Details of the running data and output are given in Table II. Repairs executed, and needed at the end of the work, are given in Table III.

(6) *Maintenance of Machinery.*

The machines were installed and worked by Sappers, who showed the greatest keenness, but lacked experience. It was found necessary to arrange for proper maintenance as distinct from operating the machines. The best tradesmen in the Company were formed into a maintenance party under a skilled N.C.O. It was this party's duty to visit all machines frequently while at work, carry out running repairs during the break and dinner hour if necessary, and make note of any larger overhauls for execution during the week-end. Drivers of machines were instructed to do no repairs or adjustments without the knowledge and consent of the maintenance party. This system worked well, and practically no delays occurred during working hours due to mechanical failures. See Table IV, for repairs carried out to machinery. For digger see Table III.

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TABLE I.—STONE CRUSHERS.

	Heron-Tree.	*Deer-Park.*
Crusher, 16 in. x 9 in. portable. Engine :	5 H.P. steam.	7 H.P. paraffin.
Belting	5 in. 5-ply Balata.	6 in. 4-ply Balata.
Fuel per hour, average including starting	80 lb. coal.	3 pt. paraffin.
Stone crushed, tons	400	410
Hours worked, hours	154	250
Average per hour, in crushers rated at five tons per hour, output, tons ...	2·6	1·64
Best output per day of six hours, tons	19	16

Working Parties.

R.E.

Working engines, and maintenance	2	1
Feeding crusher	1	1
	3	2

Infantry.

Delivering stone	14	14
Feeding crusher and sorting stone ...	3	3
Shovelling crushed stone to trucks...	5	5
Removing crushed stone	3	3
	25	25

TABLE II.—RUSTON EXCAVATOR.

(*a*) Summary of Log :—

Period.	Hours. Run.	Hours. Digging	Output Tons.	Tons per Hour.	Working Hours Lost. Mach.	Rails.	Moves.	Maint. out of Hours	Remarks.
25/6–13/7	56	43	742	17·3	5½	—	9½	2	Driver learning engine. Sprag jammed ; brakes and clutches.
16/7–3/8	86	74	1835	24·8	3½	2½	3½	6	Brake and clutch, clutch release stud, rack lock, keys, sprag lever, bucket, rope.
6/8–24/8	66	60	1150	19·2	5	3½	1	1	Attend carburettor. New rope.
27/8–7/9.	55	42	826	19·7	—	5½	11½	—	Move to new site. Working on narrow bank.
10/9–21/9	42	36	842	23·4	5	6	—	14	Main clutch broken.
24/9–8/10	51	28	560	20·0	4	1½	20½	—	Move to Catterick, 10 miles.
Total	356	283	5955	21·0	23	19	46	23	
Best day, 24/7/28	6	6	181	30·3	—	—	—	—	

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NOTE 1.—Fuel used by Ruston : 1¼ g. per hour, or 10½ per six-hour day.
NOTE 2.—The engine was originally set to run on paraffin, but as petrol was cheaper and worked better, it was converted to that fuel.
NOTE 3.—Lost working hours : *Mach.*—mechanical defects. *Rails*—alterations to Decauville track used for discharging earth. *Moves*—machine moving to new face.
NOTE 4.—Working party : Sappers—one driver, one mate, one man checking output, arranging sleepers when moving forward and clearing obstructions from bucket. The second driver was not actually necessary. Infantry : Two men occasionally to help with sleepers.
NOTE 5.—Equivalent output : a hundred men digging by hand.

TABLE III.—REPAIRS TO EXCAVATOR.

During 350 hours work.	*On completion of work.*
Straightened sprag lever 3 times (part of travelling mechanism).	Decarbonize and grind in valves (found to have been unnecessary.
Renewed bucket hoisting rope.	Straighten bucket door.
Altered carburettor setting for petrol and retimed magneto.	Fit new main clutch fabric.
Adjusted fan belt once and clutches several times.	Repair woodwork of cab.
Adjusted jammed sprag gear once, sprag levers 3 times.	Replace link bolt on hoisting clutch.
Tightened keys on control shafts.	
Renewed one broken track bolt.	
Renewed main engine clutch-thrust mechanism.	

TABLE IV.—REPAIRS TO MACHINERY.

During work 15/5/28 to 9/10/28.	*On completion of work.*
(*a*) 7 H.P. BLACKSTONE DRIVING STONE CRUSHER.	
Big-end bedded monthly.	New glasses for water drip and lubricator.
Fuel feed pipes renewed twice. (Practical jokes during week-ends.)	Bed big and little end and renew latter if found necessary.
Renewed gas-side piston ring.	New air valve spring and hot coil.
Renewed exhaust and fuel valve and governor springs.	Repair blow-lamp.
Renewed heating coil twice.	Renew joints in exhaust and water pipes.
	Decarbonize and grind in valves.
(*b*) STONE CRUSHERS, TWO.	
Nil.	Clean and fit bearings.
	Straighten and replace one main shaft.
	Fit brushes to road wheels (wear due to vibration while working).
(*c*) CAPSTAN WINCH.	
Fit seating to lubricator.	*Nil.*
(*d*) 1½ H.P. LISTER ENGINES ON CONCRETE MIXTURE.	
Decarbonized and ground in valves.	Decarbonize.
Adjusted fuel valve seating.	

TABLE V.—SOME ACCESSORIES FOR PORTABLE MACHINERY.

"Sternol" belt dressing.	Engineer's emery cloth.
"Alligator" belt fastenings, with copper or gut joint.	Assorted bolts and nuts, washers and spring washers.
Asbestos string.	Trek chains for haulage purposes (or steel slings).
"Klingerite" packing, two thicknesses.	Jacks, lifting and traversing, 6 tons.
Hand-hole packing rings.	Lubricants : Stauffer grease, axle grease.
Worsted for drip feed lubricators.	Oil, I.C. medium and heavy, also steam cyl. oil, special high grade, *e.g.*, Shell-Triple
Cotton waste and rags.	Jim Crow.
Soft soap.	

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NOTES ON PORTABLE MACHINERY IN THE FIELD.

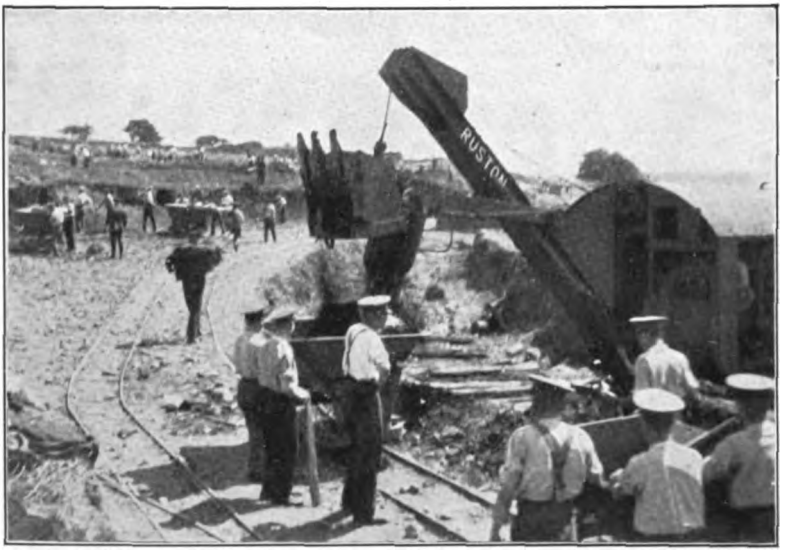

Photo No. 1. Ruston No. 4 Crane Navvy.

Photo No. 2 – Infantry Digging Party.

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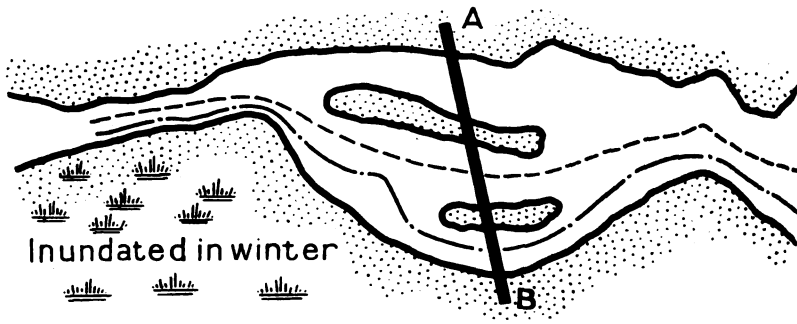
INTERNATIONAL BOUNDARY DELIMITATION.

River Boundaries.



Median Line shown _ _ _ _ _ _ _ _ _ _

"Thalweg" shown ——.——.——

Section A to B.

Fig. 1.

THE BAY OF HELA

Fig. 2.

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INTERNATIONAL BOUNDARY DELIMITATION.

A Lecture delivered at the S.M.E., Chatham, on January 31st, 1929, by MAJOR P. K. BOULNOIS, O.B.E., M.C., R.E.

THE dictionary definition of the word " delimitation " is " the fixing or settling of a limit." It is clear, therefore, that the subject of boundary delimitation involves more than merely surveying, and that side of the question will barely be touched upon in this lecture. No boundary can possibly be delimited without a map, and, as delimitations usually take place in countries which are either completely unsurveyed or else inadequately mapped for such purposes, survey knowledge is an essential equipment for the man who goes out on the ground to do the final " fixing or settling." The object of this lecture, however, is to give some indication of the technique of actual delimitation, to touch upon some of the historical cases of difficulties and disputes, and to show some of the problems which have to be solved in the case of all boundary work. A boundary, it must be remembered, is a line, that which, according to Euclid's definition, has length but no breadth. To fix and settle a line which will separate peoples, which will put individuals under the laws and customs of different nations, clearly needs much care and thought, and above all sympathetic consideration. When, in addition, economic unities are involved, the problem of finding a line which shall produce future stability is indeed a great one.

Most of the available literature on the general subject of delimitation deals with the difficulties which have arisen in interpreting boundary treaties, owing to those treaties having been drawn up on utterly insufficient geographical knowledge. It seems hardly fair, however, invariably to criticize the treaty makers in these cases. Clearly, they must do their best with the material at hand and in nearly all cases that material has been scanty in the extreme. If one considers any map of our colonies, for instance, in the nineteenth century or earlier, it is certain that about the only features thereon depicted will be

(*a*) Rivers,
(*b*) Mountains,
(*c*) Towns and villages,

as well as, of course, that bugbear of delimitation the geographical graticule, the lines of latitude and longitude. It is so natural for a hard-pressed foreign or colonial office instantly to seize on such feat-

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ures as are shown on the only existing maps, and, to the uninitiated, features like rivers and mountains seem excellent things in themselves to choose as boundaries. They will be there, they will be visible, and at any rate a river is a concrete dividing object. In fact, in past works on the subject it has always been customary to speak of "natural" and "artificial" boundaries in accordance with whether the boundary line was defined as following some topographical feature such as a river, or lake shore, or was only a line on the ground which required marking in some form or other. As will appear later, the "natural" boundaries prove more often than not to be more artificial than natural. The epithet may, indeed, be applied to the working of the minds of those who first choose the line from a map! It is natural to select such features as are shown.

Probably the best historical example of boundary delimitation difficulties being brought about by the selection of "natural" features on an inadequate map is provided by the long boundary between the United States of America and Canada.

At the eastern end of this boundary, the line was defined by the Treaty of Paris of 1783 as running up the River St. Croix as far as its "source," and thence due north to the "highlands." These highlands were further defined as dividing "those rivers that empty themselves into the River Saint Lawrence from those which fall into the Atlantic Ocean."

The first difficulty arose in discovering the River St. Croix, for no local inhabitant could be found who had ever heard of a river with such a name in those parts. Eventually, after much discussion it was decided to agree that a certain river called the Schoodic was really the St. Croix.

Then came the question of the "source." The river Schoodic has three main sources, each formed by a lake.

The position of the "highlands" or watershed between the St. Lawrence basin and the Atlantic Ocean caused years and years of dispute, for actually no rivers in that part of Nova Scotia really run into the Atlantic Ocean at all. They empty themselves either into the Gulf of St. Lawrence or else into the Bay of Fundy.

Further to the west, along the Canadian–United States boundary, another interesting case of difficulty arose. By treaty the boundary line was to run down a certain Hall stream to its junction with the Connecticut river, and thence along the 45th parallel of northern latitude. Between 1771 and 1774 this particular parallel, which also was the boundary between the states of New York and Quebec, had been determined by astronomical methods of survey, but had been fixed 3,000 yards further north than its true position was afterwards found to be. The old position of the parallel as determined by more exact methods was also found to be well north of the junction of the Hall stream with the River Connecticut.

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If the old position of the parallel was accepted the treaty definition could not in fact be fulfilled, for the boundary would reach the 45th parallel well before it could attain the Connecticut river. But in spite of this, the Ashburton Treaty of 1843 accepted the wrongly-surveyed position of the 45th parallel, and provides one of the few historical instances of a boundary wrongly surveyed and contrary to an original definition being perpetuated.

Towards the centre of the Canada–U.S. boundary, similar difficulties arose. The Treaty of Paris defined the boundary as running to the most north-western point of the Lake of the Woods, passing incidentally through a " water communication " that did not exist, and mentioning a certain " Long Lake " which no one could find.

From the most north-western point of the Lake of the Woods, an almost impossible place to find in an extremely indented, more or less circular lake, the boundary was by treaty to run " on a due west course to the River Mississippi." On investigation it was found that all the sources of the Mississippi were considerably further south than they had been shown on the map by the aid of which the treaty had been drawn up. No due west line from any part of the Lake of the Woods, let alone one from its most north-western point, could in fact ever touch any portion of the River Mississippi.

Many years of dispute naturally ensued, but in 1818 the boundary west of the Lake of the Woods was accepted as being the 49th parallel as far west as the Rocky Mountains, and later this so-called geographical line was extended to the Pacific.

It may amuse you to know that it is along this eighteen-hundred-mile line, as well as in places along the 45th parallel east of the Great Lakes, that so many houses exist to-day in which strong drink may be legally consumed at one end of a room, and all the rigours of the law, and of the Volstead Act, descend upon so much as a gulp taken at the other window !

There are many historical cases of disputes arising when a boundary is defined by treaty as following a geographical line, *i.e.*, a parallel of latitude or a meridian of longitude. Probably the best is the one which caused so much argument between the Australian states of Victoria and South Australia that they referred the matter to the Judicial Committee of the Privy Council as recently as 1913.

Their boundary was to be the 141st meridian east, but the original surveys were two miles in error. This error was probably due to a wrong value for the longitude of Sydney rather than to inaccurate astronomical work on the actual line. The boundary, however, had been marked and " proclaimed " by the Governor of South Australia (in 1847), and the Privy Council would not allow the line to be altered.

Actually the two mile error was in a westerly direction, *i.e.*, nearer to meridian 140°. The most original definition of the boundary

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laid down the line as between the 132nd and 141st meridians, so that the erroneous line came within that definition. Had the error been in the other sense, *i.e.*, making the line more than 141° east, it is likely that the Judicial Committee of the Privy Council could not have given their award to let the line stand.

Another interesting case of difficulty when a boundary is defined in relation to a geographical line, in this case a parallel, occurred quite recently on the western frontier of the Anglo-Egyptian Sudan. The final convention between the United Kingdom and France, signed by Mr. Balfour and M. Pichon in 1919, stated that the boundary between the Sudan and French Equatorial Africa (a post-war title) was to follow the waterparting between the basin of the Nile and that of the Congo " up to its intersection with the 11th parallel of north latitude."

Now in 1919 this looked a perfectly sound definition. The deserts north of the main tributaries of the Congo did not seem likely to contain any river which did not flow directly into that vast basin of Central Africa. Maps of the day showed an undoubted watershed between the basins to exist considerably north of the 11th parallel. Yet even before the final work of demarcating and mapping was undertaken (in 1921) it was known that another river basin might considerably complicate the interpreting of the treaty. The Shari river rises in the southern Steppes of Wadai and flows into Lake Chad, and many of its tributaries come from south of parallel 11 degrees north.

The Nile-Congo watershed, a definable geometric line, was found in fact never to reach the 11th parallel. In the Shala Mountains about 10°15′ North and 22° East is the meeting point of the three watersheds,

1. Nile-Congo
2. Nile-Shari
3. Shari-Congo

and the treaty of 1919 was " out of court " as regards the stretch between the Shala Mountains and the 11th parallel, a distance of some 60 miles, whence a well-defined tribal boundary was to ensue. Luckily, in this case the country involved was of no particular apparent value—ivory was its chief commercial asset—and agreement on a compromise line was reached without the matter having to go to arbitration.

As will be seen from the above, even the general definition of a boundary presents a problem of great difficulty, the major portion of which is caused by the lack of topographical knowledge of the country over which the boundary will run.

When one gets to detailed definition the problem is in some ways harder, and, even when maps are good and accurate and of fairly large

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scale, snags will always arise when a boundary line is laid down as having to follow this or that " natural " feature.

The most prolific source of difficulties are rivers, and boundaries along such will now be considered in some detail.

Rivers never divide peoples and tribes, but apart from this ethnic unsuitability of nearly every river that exists, the fact that rivers can and do change their courses makes them possibly the worst form of boundary that can be imagined. The number of disputes that have arisen in the past, owing to this unpleasant habit of rivers, is enormous, and a kind of international law has in consequence arisen which states the principle to be followed in such cases as : " If the change in the course of a river is by infinitesimally small steps, the boundary follows the river wherever it goes ; if, on the other hand, the change occurs suddenly, as may happen in flood, the new course of the river does not constitute the boundary, which remains along the old line (now possibly dry)." This principle was first enunciated by a Mr. Cushing, who is recognized as an authority on international law, about 1911, after much dispute had arisen between the United States and Mexico over the alterations in course of the Rio Grande, whose median line forms their boundary.

Canalization of rivers may also alter their courses, or at any rate the position of the main channel, and in such cases it is usual to insist on the old line in its original position with regard to the earth's surface being adhered to.

In one case, that of the Russo-Turkish boundary when it used to run along the River Pruth between Bessarabia and Moldavia (which is now a Rumanian province), a treaty drawn up in 1857 specified that should the river line as demarcated become accidentally displaced by a flood, the local authorities of both states were forthwith to have the necessary works carried out, " to return the waters of the river to their original bed such as are shown on the topographic map of the frontier." This, however, exhibits exceptional prescience on the part of the Commission appointed to delimit the boundary, and one may add, exceptional optimism.

Another major objection to the choice of a river line as a boundary is that, unless the whole of the waterway be allocated to one state, a condition which precludes all free navigation, fishing, and rights of taking water for domestic or commercial purposes in the case of one riparian, any division of a river in a civilized country complicates almost hopelessly the question of—

(*a*) Bridge ownership and maintenance.
(*b*) Lock ownership, operation and maintenance.
(*c*) Improvement of the navigability of the river in question, for instance, by " spits " on either bank designed to deepen the channel.
(*d*) General navigation.

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In spite of this, however, one bank of a river is seldom chosen as an international boundary, and division is almost invariably made by either—(See Fig. 1).

(*a*) The middle or median line.
(*b*) The valley line or line of deepest soundings, called in boundary practice the " thalweg."

Both definitions present certain difficulties. Clearly, if a river's banks are steep and high, the middle line of the water, be it at low level or flood, can quite easily be found. *Bornes repères*, or mutual beacons, are put in on either side of the river, and the boundary is the line equidistant from the two pillars. But how few rivers possess well-defined banks. Even the Thames becomes a mile or two wide in places during the winter, and in many cases of continental rivers broad marshes extend to the width of half an English county.

The word " thalweg " first came into use for international boundary delimitation in 1801 (Treaty of Lunéville), and this fixing by the valley line became increasingly popular during boundary disputes throughout the nineteenth century. The trouble of the thalweg is :—

(*a*) That it is not easily found. It means in effect the laborious work of sounding the whole river bed.
(*b*) It may be indefinite, *e.g.*, two arms of a river may be of equal depth and equal rapidity of current.
(*c*) It is more than liable to change.

In some boundary protocols the difficulties under (*a*) above have led the two interested states to accept the " thalweg " as being the line most favourable to downstream navigation at periods of low water (*e.g.*, the Rhine boundary), or as the stream line of the fastest current. In reality, however, the " thalweg " means the line running along the actual bottom of the bed, or that line which the water would follow should the volume of the river be reduced to the tiniest trickle. This latter is the simplest way in which to look upon " thalweg " in one's own mind.

That such a line is liable to constant change is the reason why the " thalweg " is now losing its popularity in boundary delimitation practice. Every article in the Treaty of Versailles, for instance, which dealt with boundaries, spoke of the " course " or " channel " (*cours et chenal*) of a river, and in Article 30 of the treaty it was laid down that these words should signify—

(*a*) The median line of the waterway or principal arm in the case of non-navigable rivers.
(*b*) The median line of the principal channel of navigation in the case of navigable rivers.

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Even so, the question of definition of the word " principal " arm or channel of navigation gave rise to considerable dispute during the various delimitations of the post-war boundaries of Europe in detail.

After rivers come watersheds as the most usual form of natural feature to adopt as a boundary. It must not be imagined, however, that a watershed line is necessarily a mountain line of sorts. In some cases, of course, waterpartings between basins of great rivers do lie along mountain ranges, but they never coincide with what is popularly known as the crest of a mountain range. The most outstanding case of this is the Himalayas, whose northern slopes give birth mainly to rivers, which eventually find their way southwards into India and not into Tibet. Both the Indus and the Brahmaputra, for instance, rise north of the main Himalayan crest and not to the south.

The lengthy dispute between the Argentine and Chile which was referred to the arbitration of the King of England in 1899, arose in fact from a disparity between a watershed and a crest line or mountain range. The wording of the treaty (1881) was about as bad as it could be, for the expressions used were direct contradictions of each other, *e.g.*, " . . . marked by the highest summits of the said Cordillera (range of mountains) which divide the waters "—and later on " and shall pass between the slopes which fall away to either side "—which in the Chilean translation was made into " between the sources of streams flowing down to either side."

The line marked by the highest summits was, of course, in the main range of the Cordillera des Andes, but the watershed between the Atlantic and Pacific Oceans, which was what the Chileans claimed, was many many miles to the east, and mostly in flat marshy country. So patently indeterminate was this continental watershed that a certain Dr. Moreno, of the Argentine Commission, managed to divert the course of the River Fenix from the Pacific to the Atlantic with the aid of 20 men in a week, just to show the arbitrator (Sir Thomas Holdich) what a dubious line the inter-ocean divide was.

Indeed, the main objection to watersheds as boundaries is the difficulty of finding them. So many great waterways of the world first come to life in marshes and flat bush country. This is notably true of the north and south lips of the great Congo basin. Both the Nile-Congo and the Zambesi-Congo watersheds lie in the flattest of flat forests, as with regard to the former the writer knows personally only too well.

A very nice point, as lawyers would call it, arises when a watershed or crest line boundary happens to find itself along the top of a vertical or overhanging cliff. In the latter case, as by definition a boundary is a vertical plane, it would appear that two boundaries might be claimed, one at the top of the cliff, and the other vertically below,

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but the lower line cannot be either crest or watershed. If the cliff is vertical it is clear that the cliff face proper belongs to neither side, and boring into it would be a violation of sovereign rights.

There are cases on record, and one extremely interesting one is current at the moment on the northern boundary of Rhodesia, where over a large area water percolates through the top strata, and no one can say to which side it eventually exudes. Watershed boundaries as a rule only take into account running water, and there clearly must remain considerable areas of either marshy ground or dry flat terrain over which it is a practical impossibility to determine the true theoretical watershed. Contours at one foot or even three inches vertical interval would be necessary before the real line could be found, and even then, on truly flat areas, the boundary would remain legally indeterminate.

In some ways, then, the crest line or *ligne de faite* is a better line to choose amongst hills and mountains than the watershed, always assuming that for some reason or other it is essential to try and follow so-called natural features. They are mostly unnatural when it comes to the peace and contentment of the persons living on either side.

Another "natural" feature which is often used in a boundary definition is a lake, and the same objections apply to the banks or median lines of such as to rivers, only in slightly less degree.

Of "artificial" features, canals, roads, existing hedges, walls, etc., there is no time to speak.

Geographical boundaries have already been explained and criticized The only truly "natural" boundary which is efficient and more or less incapable of dispute is of course the sea coast.

One aspect of delimitation which, however, is not often given the attention it deserves is what happens to a boundary when it reaches a coast. In this the question of territorial water has to be considered. There is no international law as to the distance from a coast over which a state should claim to exercise sovereignty, but only national custom and usage. The old rule was three sea miles, or a cannon shot, but hardly any nation now adheres to this distance; six, ten, twelve or even more sea miles being nowadays claimed as territorial water. The modern profession of "rum running" has in late years brought the question of the desirability of fixing by international agreement the length of a twentieth century cannon shot, so to speak, very much to the fore again. An attempt at codifying usage and custom in this matter, which is of great value to anyone faced with a delimitation problem involving sea as well as land, was made by the Institute of International Law in 1894 at their Paris conference. The rules suggested by that Institute were briefly:—

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(*a*) Six sea miles (or 12,170 yards) width of territorial water.

(*b*) The boundary of this territorial water to be parallel to the coast line, except when bays are under 12 miles broad, *i.e.*, double the width of the territorial water. In these cases the sea boundary to run six miles out from the line where the two sides of the bay are first within 12 miles of each other.

This rule of ceasing to follow the bends of a coast when a bay is less than twice the accepted width of the territorial waters claimed is pretty generally accepted, but in the matter of width of zone each nation is a law unto itself. Italy, for instance, declared for ten sea miles in 1912; Spain and France content themselves with three miles; Sweden likes four sea miles "measured from the islands, islets, and reefs which are furthest out to sea and which are not permanently covered by water."

Now, when a land boundary reaches the sea, it is international custom to consider the boundary prolonged into it by a line perpendicular to the coast. This is all very well provided the land boundary reaches the coast more or less perpendicular to it, or rather to its general line. But many cases arise in which the final portion of the land boundary strikes salt water at some creek or bay, and if a line was drawn perpendicular to either

(*a*) The actual shore or coast at the point, or

(*b*) The generalized line of the whole coast,

it is extremely likely that such a line would drive straight into land already under the sovereignty of one or other of the interested powers.

A good treaty should, in fact, define the boundary line out as far as the limit of territorial waters in no ambiguous terms. Few, however, do.

The Gulf of Danzig provided a most interesting case of this when the boundary of Poland and the Free State of Danzig came to be finally delimited in 1920. The last of the ten short paragraphs of Article 100 of the Versailles Treaty, which fixed the boundaries of this new sovereign state of 384,000 inhabitants, merely stated "thence the course of the stream mentioned above to the Baltic Sea." The stream was actually the "Grenzfliess," a brook some three feet wide. Where this brook emptied itself into the sea was just 12 miles away from the point of the Putziger Nehrung, a peninsula jutting out to almost due north of Danzig town, and already Polish terrain. A line drawn perpendicular from the Grenzfliess outlet would go straight into Hela, a village near the end of the Putziger peninsula. If drawn perpendicular to the general line of the north German coast in the Danzig neighbourhood, it would have cut right across that intensely

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important sandy spit. Then came territorial water questions. (See Fig. 2).

Surely Poland was entitled to three sea miles all round the peninsula, but six miles would have brought her territorial waters so close to those of Danzig as to overlap them. The boundary was finally settled as being a straight line from the Grenzfliess outlet, to be drawn as a tangent to the circle drawn round the point of the Putziger peninsula with three sea miles as radius, thence along that circle to where the outer territorial water boundary of Poland (*i.e.*, of the peninsula) began. A satisfactory solution and somewhat unique in boundary history. Had six sea miles been accepted as territorial water distance a similar geometric solution would have been most unfair to the Danzigers for reasons that need not be gone into here.

The settling of such knotty problems is the job of the actual Commissioners appointed under a Treaty and it will be as well now to consider how these men function.

The first thing they must remember is that they are interpreters, interpreters of a treaty, nothing more and nothing less. In all their delimitation work they must constantly strive to fathom what was the intention of those minds which finally gave the treaty birth. Critical thought about the treaty itself is useless, wasted. Get on with the job, and realize that a demarcated, fixed, and settled boundary, making for contentment and happiness even if in parts it seems unjust, is the essential objective of those who implement a treaty.

The tendency in modern days is to leave more and more of the final delimitation to the man on the spot, to the actual Boundary Commissioner. Thus, in the Treaty of Versailles, half the clauses defining the new boundaries of Germany are phrased in some such manner as :—

1. " thence to a point on the median line of Lonkener See ; a line to be fixed on the ground passing north of Neu Fietz and Schatarpi and south of Barenhutte and Lonken."
2. " thence to the southern end of Pollenziner See a line to be fixed on the ground."
3. " Thence north-eastwards to the point where the River Kamionka meets the southern boundary of the Kreis (*i.e.*, province) of Konitz about three kilometres north-east of Grunau. A line to be fixed on the ground ; leaving the following places to Poland : Jasdrowo ; Gr Lutau ; Kl Lutau ; Wittkau, and to Germany : Gr Butzig ; Cziskowo ; Bathow ; Bock ; Grunau,

and in this manner really immense latitude of choice was given to the various boundary commissioners appointed. Would that it were always so. There is no question that a successful and efficient delimitation can only be effected if this latitude is given. Make the

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treaty vague as to the geographical line, but intensely definite as to the wishes and intentions of the two signatories, and nine-tenths of boundary delimitation difficulty would be swept away. It has even been suggested that the treaty itself might roughly define *two* lines *within* which the finally delimited boundary has to run. It would be an understood thing that the final line should, as far as possible, divide this zone into two approximately equal parts but, within the zone, the appointed Commission could take the line hither and thither, fitting it to the actual topographical conditions, to economic unities, and to the tribal, racial, and social needs of the area in question. Those natural features so " naturally " chosen in the comfort of an office would not so often appear as lines on the ground finally settling the boundary. Rivers, indeed, would probably be avoided altogether. There is no necessity for them. Interpretation of such a treaty would demand good will and give-and-take between the Commissioners of the rival states, but then so does the implementing of any boundary clause even where the line itself is, in theory, exactly defined.

Unless the Commission is tri-national, cases must always arise, and do, in which agreement cannot be reached. There is no course open then except arbitration. It is quite remarkable, however, how few British Commissions working alone with an opposing nation ever seem to have failed to reach agreement. The natural thing when two nations commence a delimitation would seem to be to include a third nation to settle cases of dispute, but this is never done in our practice. A notable exception was the recent Turkey–Iraq Commission, to which the League of Nations appointed a neutral President, a Swiss gentleman, with casting vote.

Boundary disputes, on the other hand, are of course referred to an arbitrator, and the King, President, or Emperor of some neutral state has in the past always been called in. Since 1888, the King of England has once been called as arbitrator—by Chile and the Argentine. The President of the United States once—by Nicaragua and Costa Rica. The Emperor of Russia once—by France and Holland, and the throne of Spain has been invoked no less than three times: by

Peru and Equador in 1888,
Columbia and Venezuela in 1891,
France and England in 1909.

Our own boundary dispute with Brazil of 1904 was referred to the arbitration of the King of Italy.

The delimitation of new boundaries after a war can hardly be called arbitrational delimitation proper, but the Commissions appointed under such treaties are charged with seeing that the clauses affecting boundaries are fairly and accurately carried out. The two interested states have their own commissioners, and the function of the men

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appointed by the treaty is to adjudicate between their respective arguments as to the real interpretation of the boundary clauses.

No matter which class of delimitation is in progress, the first essential for the work is clearly a map. If none of suitable scale exists, one has to be made. In probably 90 % of cases in which Great Britain is concerned the mapping, survey, in fact, has to be undertaken. Opinions differ as to the width of strip over which detail should be shown, but as a rough guide ten miles on either side of the finally selected boundary is a good figure to aim at. The scale of the map naturally will vary in accordance with the amount of detail that exists. A quarter inch to one mile (1/250,000) has been found to suffice in many uncivilized parts of the world, whereas plans at a scale of 25 inches to the mile (1/2,500) were found essential for the post-war boundaries in Europe. In this connection it must be remembered that even though an almost perfect triangulation may exist, large scale cadastral plans very rarely do, and a Boundary Commission must, even in a highly civilized country, be prepared to undertake all the processes of cadastral survey. Chains, levels, theodolites, and tacheometers are, in fact, a most necessary equipment, and knowledge of their use even more so.

A very essential thing to remember about the maps is the necessity of properly transliterated names, and above all to ensure that the correct local names are found out and recorded. In most boundary protocols two lists of names are given, as it is rare that a common system of transliteration of native names exists where two European powers are concerned.

Apart from survey, officers appointed to serve on boundary commissions in uncivilized countries have an immense amount of administration to perform. The party is necessarily large, and facilities for supply are few. An escort almost invariably accompanies the commission. Pay, discipline, rations and transport questions all demand care and thought.

In civilized countries, survey knowledge is much more necessary than is commonly realized. To know the language of the other nation, or nations, represented on the Commission, is of course an essential. An immense asset on European work after the War was found to be general engineering training. Some of the arguments for and against some particular portion of a boundary were engineering questions, pure and simple. A very important problem, for instance, arose on the Danzig Free State boundary concerning a hydro-electric project on the River Radaune. Expert engineer witnesses were brought before the Commission by both sides. A settlement of the boundary there entirely by Commissioners non-conversant with electrical power problems would probably have been most unsuitable.

When proceeding to detailed delimitation, it is usually no use

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trying to consider the boundary as a whole. It is essential to divide it into sections and carry through all the survey, discussions, arguments, and hearing of local evidence, and then delimit section by section. Another point is to leave the question of mutually unsatisfactory portions of the line until the whole has been delimited according to treaty. There obviously must be some line theoretically the only interpretation of the boundary as laid down, and when that is fixed the time arrives to discuss exchanges.

Finally, there is demarcation. The distance apart and the nature of boundary pillars will vary in accordance with the nature of the country, but practice in the past has erred far too much on the side of considering the country unimportant and therefore close monumenting unnecessary. Each pillar should at least be intervisible from its two neighbours. The essential of any boundary mark is permanence. Stone pillars should invariably be used, and what is even more important and even less practised in the case of so called uncivilized countries, some form of " tell tale " should be buried before the stone pillar is erected. A brick broken into three or four pieces such that they may be fitted together again is quite sufficient, but that premises the presence of bricks. That bottles will be available, and available in large quantities, on any boundary commission, is, however, likely even in the " wilds," and no slur is here intended. A broken bottle, provided all the pieces are buried, provides just as good a " tell tale " as a brick. This habit of putting something under the boundary stone dates from early Roman days. In mediæval times national emblems were often carved upon the pillars, but nowadays the names, or even only the initial letters, of the States concerned are marked, as also the number of the stone. A very useful addition, however, is to have two lines cut in the top of the stone pointing in the direction of the two neighbouring pillars.

" Cursed is he who removeth his neighbour's landmark," but something more than oaths are required in international boundary demarcation. The position of each stone is, therefore, accurately marked on the maps accompanying the boundary protocol, but this is not really sufficient. In post-war European work some of the following precautions were taken to ensure that any boundary stone could be put accurately back into position should some " neighbour " remove it :

(1) Each stone was photographed from two positions, such positions of the camera being accurately marked on a large scale map.

(2) Distance and bearing from permanent detail, such as house corners, were measured with chain and theodolite.

(3) Distance and bearing to the two adjacent pillars was recorded. (This was invariably done.)

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(4) Rectangular co-ordinates, based on some permanently marked point as origin, for a series of pillars, were computed and recorded.

In " uncivilized " work, the best that can be done is to record either geographical co-ordinates or rectangulars. In this class of country there is nothing so good as a cut lane to show to all and sundry where the boundary lies. Jubaland has one, and now the Rhodesia-Congo boundary. The natives will surely use these lanes as roads for their cattle and themselves, and thus ensure their permanence. Cutting a ditch is another excellent way of demarcating and it has precedent in

The Savoy-France boundary demarcation of 1825,
The Turkey-Russia boundary demarcation of 1857,

and will probably be more used in the future.

How to draw up the boundary protocol to a treaty is almost a subject in itself. Suffice it to say that a protocol may occupy from six pages to three or four volumes. Everything has to be thought of. There must be a detailed textual description of the boundary, a description of each pillar, all geographical data, and a record of all cases of mutual exchange or agreement to depart from the wording of the original treaty. Then come the agreements made between the Commissioners appointed by the interested states as to such things as (i) Water rights on rivers or lakes; (ii) Fishing rights; (iii) Navigation of rivers; (iv) Locks and bridges; (v) Cases of free access; (vi) Cases of free passage for special purpose, *e.g.*, to maintain a dyke in repair or for children to attend school; (vii) Waiving of customs dues in special cases; (viii) Railway conventions.

Only two or three of such things usually come within the ken of British boundary makers, but that is only because their work more often takes place in the so-called uncivilized countries. It is well to remember, however, that uncivilized countries may soon become civilized and economically important, and in drawing up a protocol it is essential to look into the future.

Even the wildest, remotest portions of the earth's surface may yet become a Canada and a United States of America.

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CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

Saidpur Yard, showing termination of three-rail track.

Photo of Saidpur Yard, showing Metre-Gauge slewed to one side.

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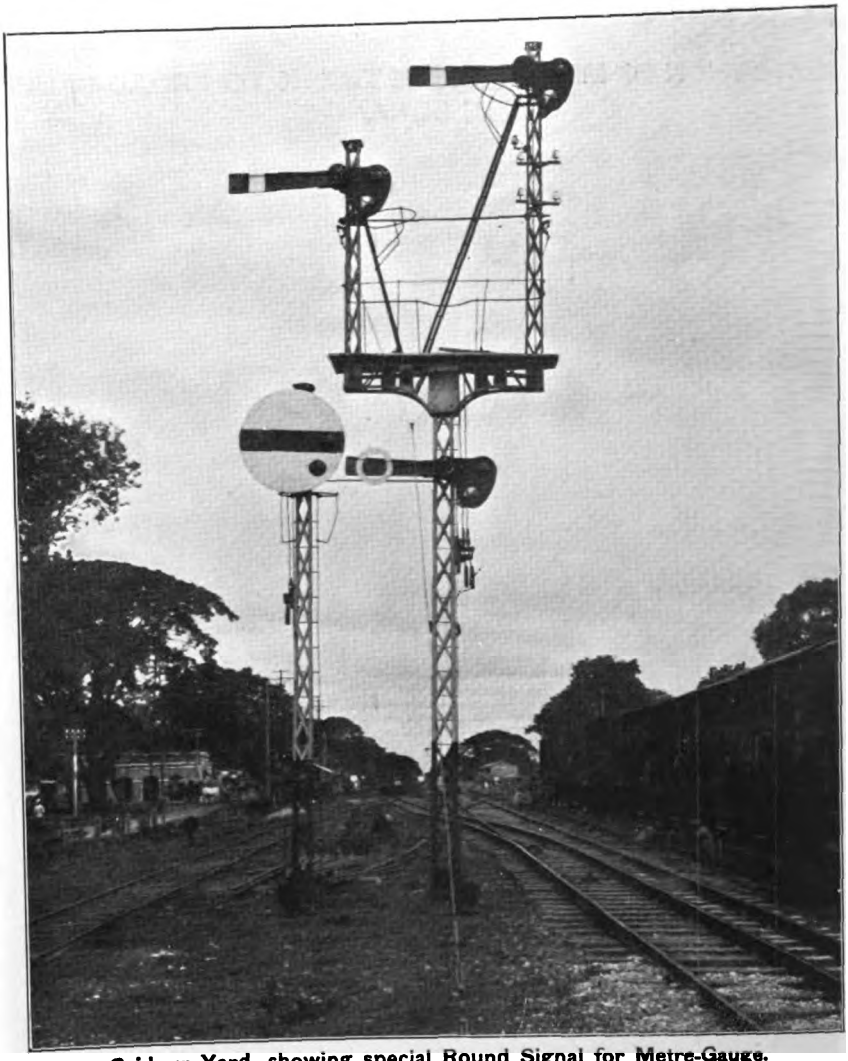
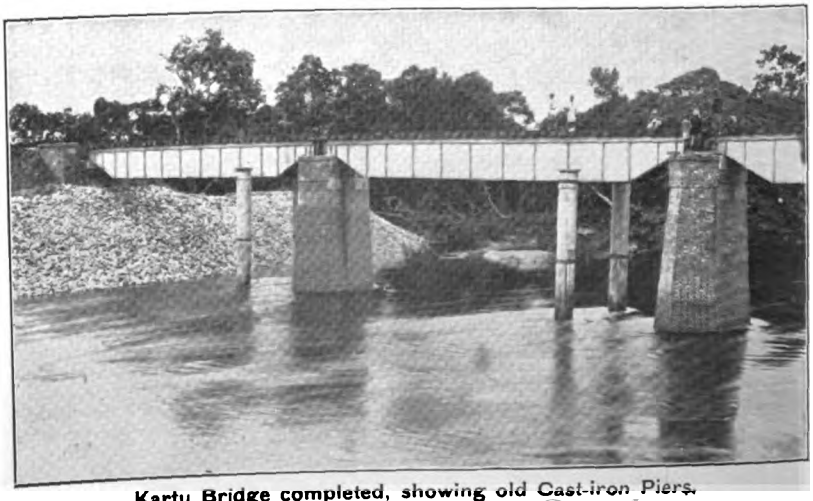


Saidpur Yard, showing special Round Signal for Metre-Gauge.



Kartu Bridge completed, showing old Cast-iron Piers.

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CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

By MAJOR E. F. JOHNSTON, R.E.

CALCUTTA is the headquarters station of the Government of Bengal during the cold weather ; for the hot weather period an annual move is made to Darjeeling in the Himalayas, about 350 miles from Calcutta. The Eastern Bengal Railway covers a little over 300 miles of this journey, *i.e.*, from Calcutta to Siliguri, and from here the journey is completed by car in about three hours, or by the 2-foot gauge Darjeeling Himalaya Railway in about six hours.

Until October 1st, 1926, the journey to Darjeeling involved two changes of gauge, one from broad to metre on the E.B. Railway and the other from metre E.B. Railway to 2-foot gauge D.H. Railway.

A change of gauge means discomfort for passengers, places limits on the time-table, in order to arrange for the important trains to arrive at transhipment points at reasonable hours, and causes delays. Delays to consignments of goods are also caused by transhipment, and loss may occur at transhipment points.

The progress of through communication on the E.B. Railway from Calcutta to Siliguri was as follows :—

The original main line from Calcutta–Poradah (see Sketch Plan) broad-gauge was completed in 1862, and was extended to Bhairamara in 1877. The extension from Bhairamara to Damukdia was completed in 1883, transhipment from here to the metre-gauge north of the Ganges (completed in 1877) was effected by ferries. The opening of the Hardinge Bridge over the Ganges (to carry two broad-gauge tracks) in 1915, and the extension of the broad-gauge 53½ miles north transferred the transhipment point to Santahar, 173 miles from Calcutta and 145 miles from Siliguri. A further stage of the change to broad-gauge was the completion to Parbatipur, 59 miles north of Santahar, in 1924.

Energetic steps were then taken to convert the remaining 85 miles. The estimate was sanctioned early in 1925, and the work was completed in record time, and formally opened by H.E. the Governor of Bengal on October 1st, 1926.

Up to Parbatipur, the change from metre-gauge to broad-gauge had been treated as a construction job, and the broad-gauge formation was made parallel to the existing metre-gauge. North of Parbatipur considerations of expense and rapidity of completion led to the decision to treat this section as a conversion.

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Plan No. 1* is an index section of the proposed line, and gives main details of the geography and the obstructions to be met on the work. It will be noted that gradients were easy, and no curves exceeded three degrees. Those curves, however, which exceeded two degrees had to be transitioned and eased so that the limit of two degrees for unrestricted speed was not exceeded.

All the work could not be carried out in the same way; for the first nine miles very special arrangements had to be made for the following reasons. Nine miles north of Parbatipur is the station and railway colony of Saidpur. This station, besides being the headquarters of engineering, traffic, and loco districts, contained also construction and repair shops for the engines and rolling stock of the metre-gauge section of the E.B. Railway, and in addition a large depot of stores for consumption in the workshops and on the metre-gauge section. Saidpur, therefore, had to have metre-gauge connection with Parbatipur, so that rolling stock and engines could proceed to and from shops, and so that stores could come up from Calcutta by B.G. vehicles and after sorting in the stores yards could be distributed to the metre-gauge. The cheapest and quickest way to allow for this was to lay down a three-rail track, whereas the remainder of the conversion was carried out with four rails, as explained under permanent way.

After work was commenced, a slight delay was caused by the receipt of orders to work to recommended dimensions for the broad-gauge. This meant allowing for considerably larger running dimensions and an increase in axle loads. As examples of the difference to be allowed for, it is sufficient to state that spacing of tracks in passenger yards was increased from 15 ft. 6 in. to 16 ft. 9 in., necessitating an increase in overall length from facing point to facing point of about 300 feet, and also axle loads to be allowed for were increased from 18 tons to 22½ tons.

At the same time that the project for the conversion of the metre-gauge main line from Parbatipur to Siliguri was proceeding, another large project had to be considered and completed, namely, the remodelling of Parbatipur passenger and goods yards.

Parbatipur is the junction between the main north to south line and the east and west line to and from Central India and Assam; the former line was now to be entirely broad-gauge, whereas the latter was to remain metre-gauge. This necessitated, besides considerable alterations to passenger tracks, the complete remodelling of the goods yard to convert it from a junction for metre-gauge traffic into a transhipment yard for dealing with traffic between metre and broad-gauge districts.

The details of this latter project and the methods employed to complete it are too numerous to mention in this article, but a comparison showing the details of expenditure under the two projects is

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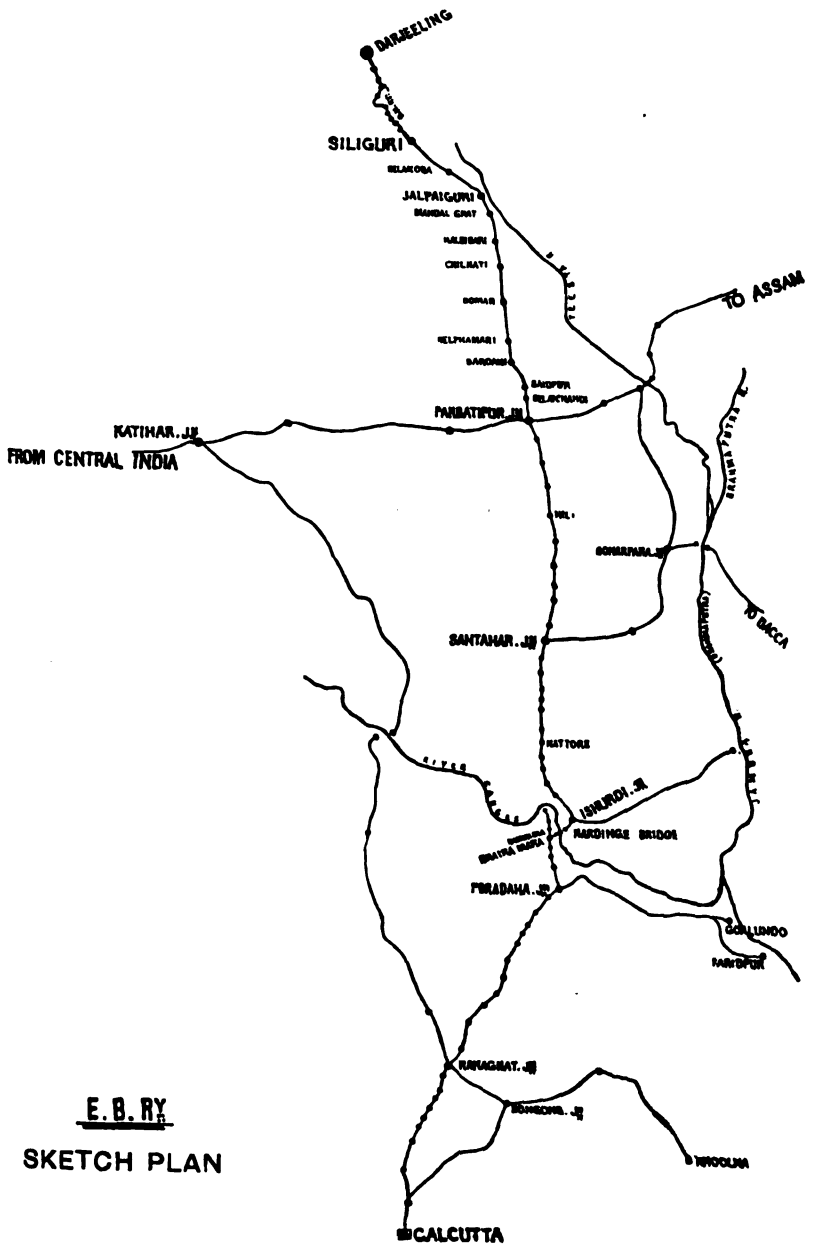

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instructive; in addition, this latter project is mentioned because the necessity for its completion vitally affected the question of staff and supply of stores.

The gross estimate for the conversion was Rs. 7,500,000, and net, after allowance for credits of old materials, Rs. 6,750,000, or Rs. 78,000 per mile (at 1s. 6d. per rupee — £5,888). The proportions in which this amount is allotted in important heads of the estimate were approximately :—

Earthwork	4½ %	
Bridges	10½ %	
Permanent way ..	71½ %	includes ballast and points and crossings
Signalling	6 %	
Interlocking		
Loco arrangements ..		

The balance of 7½% is accounted for under preliminary expenses, land, installation of electric light and power at Siliguri, salaries and other minor items.

The estimate for remodelling Parbatipur yard was Rs. 2,600,000, or at 1s. 6d. per rupee, £195,000.

The approximate distribution of this sum over different heads of the estimate is :

Earthwork	13½ %	
Permanent way ..	33 %	includes ballast and points and crossings
New platforms ..	4%	
and Overbridge ..		
Staff quarters.. ..	26%	
Signalling	17 %	
Interlocking		
Loco arrangements ..		

The remaining 6½ % is accounted for under preliminary expenses, land, salaries, etc.

The difference in the distribution of cost in the two estimates is due to the following, namely : Parbatipur is low-lying, and therefore large quantities of earthwork were required ; this had to be brought in by ballast train from outside, and very great delays were experienced in bringing in trains, as the junction is an extremely busy one. Parbatipur now became a large transhipment point for goods, and a broad-gauge engine changing station, necessitating the construction of quarters for transhipment coolies and supervising staff, and a large engine shed and quarters for drivers, firemen and running staff.

Immediately these projects were sanctioned, steps had to be taken to organize staff and the work, so that completion of the projects was obtained with the greatest possible speed. The reason for this

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was that the enormous amount of work entailed had to be done under main line traffic, and it necessitated certain limitations on the traffic which it was in the interest of the railway to remove as soon as possible.

The work therefore approximated to that which an R.E. officer might be called on to perform on active service, where speed is such an important factor.

The points which arose immediately were arrangements for (*a*) work; (*b*) staff; (*c*) materials.

Although these points are set down in a certain order they are really interdependent, and consideration of any one of them involved decisions as to the others.

(*a*) Arrangements for the Work.

The estimate for the conversion was sanctioned at the end of January, 1925; the earliest date by which arrangements could be worked out and staff collected appeared to be March 15th.

It was immediately obvious that the progress of work on the bridges would be a considerable factor in determining the final date of completion for the following reasons. There were 111 bridges of 147 spans. Each bridge required considerable alteration, and 49 of them required entirely rebuilding. Although work was so organized that only one diversion was found necessary, it was necessary for the safety of the travelling public to impose a dead stop restriction, with five miles per hour speed over the bridge at each bridge during alterations. There were 10 masonry spans which it was decided to leave untouched, the track being listed to give a two-foot cushion.

There were thus left 101 bridges, each of which would require at least one four-hour block to put on a restriction and a similar block to remove restriction, and a third block for changing girders. A total of 1212 hours block, or a four-hour block on 303 working days if only one bridge per day was tackled. It was also estimated that each bridge would take at least three weeks to complete, or a total of 303 weeks or nearly six years for the whole work.

To complete this work within twelve months, and allow for contingencies and for changing girders, and for possible interference by the monsoon, besides considering the obviation of as many delays to traffic as possible, it was decided to take one bridge in each block section of the line in hand at a time. There were 11 block sections between Parbatipur and Siliguri, the time usually allowed for a dead stop restriction is five minutes, a total loss of time, therefore, on the run between Parbatipur and Siliguri of 55 minutes had to be allowed for. The Traffic Department was therefore immediately approached to alter their time-table. This required considerable re-arrangement of trains and protests from the travelling public for the delay, but was efficiently arranged by the Traffic Department. It was very

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satisfactory, therefore, when, in April, 1926, exactly one year after the restrictions were imposed, most of them were withdrawn.

There was an alternative method of working on the bridges, and that was to start work from one end and work through; this would have simplified supply of materials, supervision, and the work generally, but would have necessitated alterations in the time-table every time a block section was completed and restrictions were moved into the next block section; this labour could not be contemplated, and the other method mentioned above was adopted.

Table No. 1 shows the distribution of bridges in the various sections and the progress of construction up to December 4th, 1925.

A perusal of the table shows that the section Siliguri–Belakoba was the heaviest, but it was found possible eventually to allow two restrictions in this section without any alteration to the time-table. The only other section which required special care was from Domar to Nelphamari; this was tackled by putting two restrictions and eventually three without altering the time-table after sections on either side were completed and no longer wanted their allowance of time. This section being in the middle of the run, trains could make up time lost in this section by not using the allowance on either side.

It was decided that staff could be collected and sufficient materials distributed for a start to be made towards the end of March. Under ordinary conditions of work in this part of Bengal, work should have ceased about the middle of June on account of the rains, and would not have recommenced till the beginning of October. This would have meant a considerable delay to the work; it was therefore decided to ignore the monsoon as much as possible.

In this we were assisted by a high tension electric transmission line between Parbatipur and Saidpur at 3,300 volts. By arrangement with the Electric Department a 10,000 gallon pump was borrowed, and arrangements made to tap the transmission line where required and transform down to 440 volts to work the pump. This arrangement worked so satisfactorily that there was no delay at all in the work, except during the short periods when there was too much rain for labour to be at work.

For work north of Saidpur, about ten centrifugal pumps of 2,000 gallon capacity direct-coupled to a Petter's oil engine were purchased. They were mounted on a frame to make them portable. They ran on kerosene oil and required one man each to look after them, as compared with a labour force of 16 coolies working in two shifts on an unsatisfactory lift-and-force or contractor's pump.

The monsoon in Bengal is followed by a universal holiday of about 14 days called "The Pujas." Linking, therefore, was arranged to commence about the middle of October, except for the portion Parbatipur to Saidpur, which it was expected would be complete by then.

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TABLE No. 1.

SPANS.

Section.	6 ft. 6 in.		9 ft.–10 ft.		12 ft.–14 ft.		17 ft.–20 ft.		25 ft.		40 ft.		60 ft.–75 ft.		Total	Completed 4.12.25
	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done		
Parbatipur–Belaichandi ...	4/3	4/3	4/2(*a*)	4/2	1/1	1/1	2/2	2/2	—	—	2/1	2/1	—	—	13/9	13/9
Belaichandi–Saidpur ...	—	—	3/3	3/3	3/2	3/2	—	—	—	—	2/1	2/1	—	—	8/6	8/6
Saidpur–Daroani	1/1	1/1	3/2	3/2	4/1(*b*)	4/1	—	—	1/1	1/1	3/3	3/3	—	—	12/7	12/7
Daroani–Nelphamari ...	2/2	2/2	2/2	0/0	4/3	3/2	—	—	—	—	—	—	—	—	8/7	5/4
Nelphamari–Domar ...	5/5	5/5	10/5(*c*)	8/3	4/4	1/1	3/3	1/1	—	—	2/1	2/1	—	—	24/18	17/11
Domar–Chilhati	1/1	1/1	4/3(*d*)	3/2	2/1	0/0	7/5	7/5	—	—	—	—	—	—	14/10	11/8
Chilhati–Haldibari ...	3/3	1/1	9/3	3/2	3/3	3/3	—	—	—	—	—	—	—	—	15/9	7/6
Haldibari–Mandalghat ...	2/0(*e*)	0/0	4/1	4/1	2/1	2/1	—	—	—	—	5/3	5/3	—	—	13/5	11/5
Mandalghat–Jalpaiguri ...	—	—	All arches				—	—	—	—	—	—	—	—	—	—
Jalpaiguri–Belakoba ...	2/1	1/1	5/4	5/4	4/4	4/4	2/0	0/0	—	—	2/1(*f*)	0/0	—	—	15/11	10/9
Belakoba–Siliguri	1/1	1/1	12/10	11/9	2/2	2/2	7/2(*g*)	5/2	—	—	5/2(*h*)	0/0	6/2	0/0	33/19	19/14

(*a*) 4/2—10 ft. converted to 2/2—20 ft. spans.
(*b*) Two land spans of box abutment bridge included.
(*c*) 6/3—10 ft. converted to 3/3—20 ft. spans.
(*d*) 8/4—10 ft. converted to 4/4—20 ft. spans.
(*e*) Land spans for box abutment bridge included.
(*f*) Ditto.
(*g*) Ditto.
(*h*) Land spans for Sahu bridge included.

4/3 means total of 4 spans and 3 bridges, *i.e.*, three bridges had one span and one bridge two spans.

2/0 under 6 ft. 6 in. and 17 ft. spans means spans put in at the ends of existing 40 ft. spans, and therefore number of bridges is 0, *i.e.*, they are included under 40 ft. spans.

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(*b*) ARRANGEMENTS FOR STAFF.

Although the two projects, conversion and Parbatipur remodelling, were separately sanctioned, staff was organized to carry on both simultaneously under the Executive Engineer, E.B. Railway, Saidpur, who had in addition to these projects a little over 100 miles of metre-gauge open line to maintain, including a ferry ghat at Fulchari, on the Brahmaputra River.

The open line was supervised by one Sub-Divisional Officer, with the usual complement of staff. The two projects were split up between two Sub-Divisional Officers as follows :—

Sub-Divisional Officer, I.—Parbatipur remodelling and conversion Parbatipur to Domar, 32 miles, including Saidpur headquarters, plus brick and lime manufacture.

With 2 Permanent Way Inspectors.

No. 1—Parbatipur remodelling and main line to Saidpur inclusive.

No. 2—Saidpur exclusive to Domar inclusive.

Each Permanent Way Inspector had one Assistant Permanent Way Inspector when available.

With 3 Works Subordinates.

No. 1—For Parbatipur remodelling and staff quarters.

No. 2—For bridges Parbatipur to Saidpur and brick and lime manufacture, and Saidpur colony, with one assistant.

No. 3—For bridges and station alterations Saidpur exclusive to Domar inclusive.

Sub-Divisional Officer—Construction.

Domar exclusive to Siliguri, including ballast quarry at Siliguri and its eleven miles of siding, with two Permanent Way Inspectors and three Works Subordinates organized on the same lines as for No. 1 Sub-Divisional Officer.

Office Work. The estimate allowed a hopelessly inadequate staff for this, and work suffered, especially the accounts; these were complicated by the fact that, owing to the decision to allow for recommended standard dimensions, an entirely new estimate had to be prepared; a further complication was then added in the shape of new rules for allocation of expenditure. The immediate result of this was that the estimate on which booking of expenditure had to be made was not sanctioned until July, 1926, when the bulk of the work had been completed and expenditure incurred.

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Labour. The recruitment of labour became a serious problem, a sufficient staff for work up to Jalpaiguri was eventually raised, but between Jalpaiguri and Siliguri it was almost impossible to attract labour. Work in Siliguri itself was often seriously delayed by wholesale desertions from the labour staff, all due to the bad climate. Eventually labour had to be recruited at enhanced rates of pay, and special arrangements for housing them and for transport to their work had to be made.

Linking and permanent way work were completed by departmental labour, the remaining work being let out to contractors.

There were large numbers of petty men, each of whom could take on small jobs, but they were not contractors in the true sense of the word, all supervision of works and the supply of materials had to be done by the railway, the contractors becoming suppliers of labour only.

(*c*) Arrangements for Materials.

Under this heading is included,

(1) Bricks, mortar, cement, steelwork, etc., for buildings and bridges.

(2) Permanent way materials, including tools for gangs.

(3) Tools and plant.

All requirements were worked out by early February, and indents were placed, but supply was slightly delayed owing to changes in policy and design as already noted. A considerable time was spent in the calculation of stores required, as it was essential to know exactly what materials were to go to each bridge, building, or work, so that the ballast train arrangements could be worked out, and it was subsequently found that the time had been well spent.

Rails were 75-lb. F.F., and joints were strengthened by the use of Joyce's patent fish plates. These plates had been used with success on the B.N. Railway, and were used here so that the light section, *i.e.*, 75-lb. rail, could be used for the expected axle load, causing a saving of about Rs. 3,000 per mile of track.

Sleepers were of sal, and were obtained mostly from the Central Provinces of India. They were of the usual size, 9 ft. x 10 in. x 5 in. About 200,000 were required.

Crossing sleepers of the same section, but up to 16 ft. long, and bridge timbers varying in size from 8 ft. to 9 ft. long and 10 in. wide, and from 8 in. to 10 in. deep, about 1,000 in number, were also obtained from the same source.

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Other materials required included,

Bricks in 1925 .. 10,000,000
„ in 1926 .. 7,500,000 } of all classes.

Steel Girders.

21 spans of 6 ft. 6 in.
56 „ „ 10 ft.
27 „ „ 12 ft. to 14 ft.
21 „ „ 17 ft. to 20 ft.
1 „ „ 25 ft.
21 „ „ 40 ft.
2 „ „ 75 ft.

Ballast, 1,500,000 cubic feet.
Ballast was distributed from Siliguri.
Bricks, mortar, etc., from Saidpur.
Balance of materials were distributed from Parbatipur.

A total of at least 200,000 tons of materials had to be arranged for and dealt with, and eventually distributed to the work by ballast train (metre-gauge). The average load of a metre-gauge train was 50 (trucks) x 10 (tons) (assuming full loads) = 500 tons per train. There were thus 400 train loads of materials to be distributed on the open line where there was heavy main line traffic. This, therefore, required special organization. Delays to ballast trains were inevitable, but they were reduced as much as possible in the following manner:

Arrangements for Ballast Trains.

Two sidings for stabling ballast trains were put down, one at Nelphamari and one at Belakoba, so that traffic yards could not be blocked by stabled ballast trains. Time-tables for running trains were obtained from the Traffic Department. These time-tables allowed for one up train in night and early morning, loaded with permanent way material, and one up train in late afternoon for empty stone train returning. One down train in early morning for loaded stone train, and one down train in evening for empty permanent way train.

Loaded trains would run from their terminal station and arrive at destination anywhere on line in the early morning. After unloading they would wait until they picked up the time of the return special. Owing to the amount of traffic on the line, and to avoid detentions to all trains by the late running of one, orders were issued that, if a train missed its return timing for any reason, it was to wait and pick up its timing the following day.

The time-tables for ballast trains are given in Appendix I as a matter of interest.

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Although "A" up and "B" down timings were arranged for permanent way ballast trains, and "D" up and "C" down for stone ballast trains, other trains with other materials would run to these timings when dates were available.

In arranging for distribution of materials the following points had to be considered :

1. Only one train could work in one section at a time.
2. Permanent Way Inspectors had to be kept well fed with materials.
3. It was important to know on what days and in which sections trains would work, so as to allow for blocks for alterations to bridges.
4. All trains must be fully occupied.

The problem was tackled as follows :—

First, a programme for distribution of permanent way material was got out.

One mile of material per train was found to be a satisfactory quantity for one metre-gauge train. These rakes were arranged two running and one spare loading. Running trains were labelled B.T.C.4 and B.T.C.5, and had two engines and two guards. In addition to distributing permanent way, linking trains were detailed to bring back released metre-gauge sleepers. The trains were therefore allowed two days per trip.

An abstract of programme between December 17th and 29th is as follows :—

DECEMBER.

Date.	*B.T.C.4.*	*B.T.C.5.*
17th ...	Dept. Parbatipur 01.15 hours, unloaded mile 277, stable.	—
18th ...	Complete work, load M.G. sleepers and return as "B" Down.	Parbatipur Dept. 01.15 hours, unloaded at mile 303, stable.
19th ...	Engine to Shed.	Complete work, load M.G. sleepers and return as "B" Down.
20th ...	Parbatipur Dept. 01.15 hours, unload at mile 250, stable.	Engine to Shed.
21st ...	Complete work, load M.G. sleepers and return as "B" Down.	Parbatipur Dept. 01.15 hours, unload at mile 304, stable.
22nd ...	Engine to Shed.	Complete job, load M.G. sleepers and return as "B" Down.

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DECEMBER.

Date.	*B.T.C.4.*	*B.T.C.5.*
23rd ...	Parbatipur Dept. 01.15 hours, unload at mile 278, stable.	3 days' leave to staff.
24th ...	Complete work, load M.G. sleepers and return as " B " Down.	
25th ...	Christmas Day } 3 days'	
26th ...	*Nil.* } leave to	Parbatipur Dept. 01.15
27th ...	*Nil.* } staff.	hours, unload at mile 305, stable. Complete work, load M.G. sleepers and return as " B " Down.
28th ...	Parbatipur Dept. 01.15 hours, unload at mile 251, stable.	Engine to Shed.
29th ...	Complete work, load M.G. sleepers and return as " B " Down.	Parbatipur Dept. 01.15 hours, unload at Mile 279, stable.
30th ...	Engine to Shed.	Complete work, load M.G. sleepers and return as " B " Down.
	etc.	etc.

This programme was then plotted on a form (see Table No. 2). This showed clearly what sections were occupied. It was then possible to plot on the form the sections in which stone ballast trains could work and their orders were issued accordingly.

Blocks for alterations to bridges and arrangements for supplying materials and girders for bridges could also be made from this form and orders issued.

Land is always a troublesome proposition, and negotiations for it should always be opened up about a year before any work starts. However we were lucky in this project, as we required very little and had the close co-operation of the Civil Department. Earth for widening the bank was obtained, where necessary, by private arrangement with the cultivators.

Earthwork.

The existing bank averaged 17 ft. in width, with an average height of about 5 feet. This width had to be increased to 20 feet, formation level being kept the same. The original bank was first thoroughly benched, fencing was shifted, and then earth thrown up till the required section was obtained.

Bridges.

There were 111 bridges, totalling 147 spans varying from 6 ft. 6 in. to 75 feet. In each case girders had to be changed to take broad-

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TABLE No. 2.

TABLE FOR DECEMBER 17TH TO 29TH.

Section.	Miles.	17	18	19	20	21	22	23	24	25	26	27	28	29
Saidpur-Daroani	242½—250							M	M					
Daroani-Nelphamari	250 —255	M	M		x	x							x	x
Nelphamari-Domar	255— 265	B		M										M
Domar-Chilhati	265 —275						M						M	
Chilhati-Haldibari	275 —280½	x	x					x	x				M	
Haldibari-Mandalghat	280½—289			B	B									
Mandalghat-Jalpaiguri	289 —295	B			B			B						
Jalpaiguri-Belakoba	295 —305		x	x		x	x				†	†		
Belakoba-Siliguri	305 -318½	†	†	†	†	†	†	†	†	†	†	†	†	†

† Stone trains. x Linking trains. M. Material trains. B. Line blocked.

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gauge loads, and extensive alterations were required to the masonry. 47 small bridges were entirely rebuilt, 52 were altered, and the two larger bridges, Kartu, three 60 ft. spans, and Sahu, one 40 ft. and two 75 ft. spans, were entirely rebuilt, ten masonry arch bridges were considered safe and allowed to remain, the cushion to top of arch was, however, increased to two feet in all cases.

Bridges are placed in two classes, those of over 1,200 ft. waterway being termed major bridges, and those under 1,200 ft. waterway, minor bridges. There were 18 major bridges. The two already mentioned and the Talma, two 40 ft. spans and one 60 ft., and 15 bridges of spans varying from one 40 ft. to three 40 ft. All of these bridges, except one of two spans of 40 ft., and the Kartu and Sahu, were considered strong enough; they therefore required alterations only to bed stones to allow the correct depth for B.G. girders, formation level having been kept the same. In some cases, where abutments were of the box type and did not allow room for B.G. sleepers, short land spans were added. The Kartu and Sahu bridges as they existed were bow-type girders supported on piers and abutments of 2 ft. 6 in. diameter cast iron screw piles, two piles to each pier, connected by a capping girder. These piles had been put down many years ago, and it was impossible to ascertain

(*a*) whether they had been corroded by the filling or by action of water,

(*b*) what load they might be expected to carry safely.

It was therefore necessary to rebuild both.

The Kartu, three spans of 60 ft., was designed to be on the original centre line; a diversion was therefore made about ¾ mile long with one span of 60 ft. This temporary bridge was built on wooden pile abutments. A factor of safety of three in Wellington's formula $\frac{(12\ WL)}{S+1}$ was used, and the bridge showed no sign of failure during the three and a half months it was in use.

Open founds were allowed for in the abutments, but there was so much water present that it was found impossible to adhere to this design. Founds were therefore built on wooden well curbs 25 ft. x 14 ft. 6 in., sunk four feet below L.W.L., and filled to a height of 4 ft. with 1 : 3 : 6 concrete. These have proved satisfactory, and are well protected by the guide bunds and stone pitching. The new bridge was completed in four months, the work done including 1,000,000 cubic feet earthwork, sinking oval wells 20 ft. x 11 ft. for 50 feet, and about 13,000 cubic feet masonry. Masonry consisted of first class burnt bricks, 10 in. x 5 in. x 3 in. laid in 1 : 5 cement

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mortar; this mortar was strengthened to 1 : 4, and then 1 : 3 towards top of piers and abutments. Well sinking was carried on day and night, and was much delayed by large stones jamming in the teeth of the dredger. Each well had two compartments, and dredging with eight cubic feet dredgers worked from steam hoists was carried on simultaneously in both compartments till steining was sunk near water level; dredging operations were then transferred to the other well while steining was added to the first. The final set of the wells was obtained by firing small charges of dynamite. Sidings from the main line at site of work were laid down, and sanction for their use obtained from the Senior Government Inspector of Railways. These sidings were isolated by trap switches from the main line; these trap switches were coupled to the siding points in main line, which were locked with one-way lock, the key of which was kept at the next station. The working of the sidings was covered by working rules arranged by the Traffic Department.

The Sahu Bridge, two 40-ft. and two 75-ft. spans, was designed to cross the river at a different angle from the existing bridge. Colonel Sir G. R. Hearn had studied Bengal rivers, and had decided that bridges should not cross them at right angles to the stream at the point chosen, but at right angles to the general course of the river. This was done in the case of the Sahu Bridge, the old alignment being used to complete the guide bunds. The centre pier of this bridge, which carried two 75-ft. spans, was built on an oval well 25 ft. x 14 ft. 6 in., sunk 35 feet, and the other two piers were built on similar wells to the Kartu, sunk 30 feet.

Masonry and mortar were the same for both bridges, and a siding was laid down for this bridge, as in the case of the Kartu.

Between Parbatipur and Saidpur, ordinary standard broad-gauge girders were used, but, as there was a three-rail track to take both metre-gauge and broad-gauge, special timbers had to be used. These timbers were calculated to be 10 in. x 10 in., and they had to be spaced at 20 in., the maximum for metre-gauge, this to be the permanent track. Between Saidpur and Siliguri, as a temporary measure, four rails were laid on the new broad-gauge sleepers, and it was found that bridge timbers 10 in. x 8 in. were sufficiently strong as a temporary measure. The usual size of timbers being 10 in. x 6 in.

As in the arrangements for distributing materials, etc., a complete programme for changing girders had to be worked out, so that traffic on the one hand and the work of the conversion on the other were not delayed.

Work started on 24.3.26, and was timed to finish, except for Kartu

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and Sahu, on 20.5.26. An abstract of the programme between Jalpaiguri and Belakoba is attached :

Bridge No.	*Mileage.*	*Spans.*	*Date of change.*
191	295/20–21	One 13 ft.	30.4.26
192	296	One 6ft. 6in.	30.4.26
193	297/7–8	One 13 ft.	1.5.26
194	298/3–4	One 6 ft. 6 in.	1.5.26
195	299/9–10	Two 10 ft.	3.5.26
196	299/22–23	One 10 ft.	3.5.26
197	300/17–18	One 13 ft.	3.5.26
198	301/17–18	Two 40 ft. and two 17 ft.	4 and 5.5.26
199	302/19–20	One 10 ft.	6.5.26
200	303/4–5	One 13 ft.	6.5.26
201	304/10–11	One 10 ft.	7.5.26

All girders except 40-ft. spans were man-handled into track; staff required was Bridge Inspector, Permanent Way Inspector, and two gangs of one mate and 18 men, of which one gang were Bombay Khalassies.

Permanent Way. All 75 lb. F.F. on wooden sal sleepers 9 ft. x 10 in. x 5 in., except for points and crossings, where 90 lb. F.F. "R" section rails were used. Bearing plates were not used ; sleepers were adzed for the rail seat before issue to the line.

Between Saidpur and Parbatipur the old M.G. track was dismantled and new track (three-rail) was laid, the new work being joined up to existing work to pass traffic, with specially prepared junction fish plates.

The left-hand rail was spiked to sleepers first, track straightened, and then metre-gauge rail spiked with a metre-gauge rail gauge and B.G. right-hand rail spiked with B.G. rail gauge. Working hours were limited to from 8 a.m. to 12 a.m. daily, but progress was usually half mile a day.

For the linking north of Saidpur special arrangements had to be made. It was necessary to keep the metre-gauge running without restrictions until the last possible minute and, at the same time, have the broad-gauge ready to bring into use for main line traffic throughout a distance of 75 miles in 12 hours. Broad-gauge track had therefore to be laid and straight, and also there had to be M.G. rails straight and properly supported.

The problems encountered were :

(1) Metre-gauge rails varied in length from 30 to 36 feet, whereas all B.G. rails were 36 feet.

(2) Metre-gauge rails were fished with a plate 18 in. long of club fashion, *i.e.*, the plate fitted round the bottom flange of the rail ; this prevented the placing of a B.G. sleeper under the joint of the metre-gauge when it was necessary to do so, to keep B.G. sleeper spacing correct.

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It was decided to carry out the linking as follows, the plan worked very well, metre-gauge traffic ran safely and without diminution in speed, and the first up inspection special of the broad-gauge, the first train to use the new B.G. track, travelled at 40 miles an hour with perfect comfort and safety.

First, metre-gauge track was opened out and B.G. sleepers inter-spaced between M.G. ones. The next day, the left or west B.G. rail was fished up for several rail lengths, and sleeper spacing marked on the rails. The M.G. was then dismantled and the west B.G. rail spiked to B.G. sleepers.

2. The east or right M.G. rail was then spiked to the B.G. sleepers with the aid of a special gauge.
3. Metre-gauge track was completed by spiking west M.G. rail, using a M.G. rail gauge from east rail.
4. Broad-gauge was completed by spiking B.G. east rail, using B.G. rail gauge from west rail.

To overcome the second problem detailed above, a certain number of M.G. fish plates were planed in the loco shops at Saidpur to take off the bottom flange. These were substituted for the club-shaped fish plates only where metre-gauge rail joints coincided with broad-gauge ones, where sleeper spacing at joints of B.G. track was interfered with. Where M.G. joints occurred in the middle of B.G. rail lengths, fish plates were not altered and sleepers left slightly out of their final spacing to be corrected when the M.G. was dismantled. It is perhaps unnecessary to state that the number of M.G. fish plates planed was kept at a minimum for two reasons, one was the cost and the second the time required.

All work was done between trains without blocking the line, and progress, not including a final packing, was from half to three-quarter mile a day with 500 men.

Points and Crossings.

All turnouts from the main line for passenger train loops were 1 in 12 with 36-ft. spring switches, and for goods sidings 1 in 8½ with 15-ft. switches. All turnouts in the main line were 90 lb. F.F. rails "R" section.

Turnouts in goods loops and sidings were 1 in 8½ 75 lb. F.F. rails.

There were two methods of arranging for installing the broad-gauge points and crossings.

(*a*) To link them up ready at the side and slew in at the appointed time.

or (*b*) Slew out the metre-gauge at the position of B.G. turnouts and lay broad-gauge turnouts in their final position.

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The second method was accepted in order to allow the Signal Department to fit all their locking gear and to reduce the amount of work to be done during the actual period of change over from metre to broad-gauge. Everything that tended to reduce or obviate work in the final change was considered. Photo of Saidpur Yard shows M.G. slewed out to one side.

For the three-rail track between Parbatipur and Saidpur the metre-gauge had to turn out from the track first before any B.G. turnouts could come in. Sanction for the use of the three-rail track had to be obtained from the Senior Government Inspector of Railways, Calcutta, and after discussion he approved, but ordered for the metre-gauge single interlocked switches with special signals.

At Parbatipur, the junction between east and west metre-gauge, south broad-gauge, and north mixed-gauge, very special arrangements had to be made. The lay-out was designed and drawn on a scale of 40 ft. to 1 in. Each diamond and turnout lettered, and then full-scale drawings of each prepared. Diamonds and turnouts were manufactured in the E.B. Railway signal shops and lettered and sent up to Parbatipur. They were all linked up between tracks and slewed into position between trains to a programme previously worked out.

This work was included as part of Parbatipur yard remodelling, which is too big a work to be included in this account; it is only necessary to say that organization of the work was the crux of the job.

Staff, stores, etc., were arranged, every little detail of work to be done was tabulated, and then a programme of every day's work made out and issued to traffic and loco, as well as engineering, staff about a month before work actually started.

Between Saidpur and Siliguri two methods of dealing with the laying of points and crossings were employed.

The plan of Daroani Station shows both. This plan also shows details of the work left for the actual period of change over. This plan was issued to the engineering representative, together with the following programme of work, and shows how the actual change over took place. It will be noted in plan that there is a three-rail track in front of platforms.

This was necessary so as to ensure that both broad-gauge and metre-gauge centre lines conformed to standard dimensions.

M.G. centre of track to face of platform = 4 ft. 5 in. B.G. centre of track to face of platform = 5 ft. 6 in. Difference 1 ft. 1 in.

$\frac{1}{2}$ M.G. = 1 ft. 7 11/16 in.
$\frac{1}{2}$ B.G. = 2 ft. 9 in.
Difference = 1 ft. 1 5/16 in.

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CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

DAROANI

SEPTEMBER 29TH 30TH

1926

WORK FOR 29TH SEPT AFTER 2DN

DISMANTLE M.G. & LINK B.G. AT : 2:36 75LBS 4 RAILS

C.D : 2. 90LBS RAILS

E F : 1. 36 75LBS 4 RAIL

I J : 1. 36 " " "

K L : 1. 36 " " "

W X : 1. 36 / 1. 18. 3 " " "

Y Z : 1. 36 " 6 "

α β : 1. 36 " " "

: 1. 16 $7\frac{5}{8}$ RAIL 6 AT ONE END
4 AT NORTH END

: 1. 25. $4\frac{3}{8}$ RAIL 90LBS $4\frac{1}{2}$ BOLT SPACING AT SOUTH END OF RAIL

JOYCES COMPOUND FISH PLATES

AN BN : 4. 36 75LBS 4 RAIL

WORK FOR 29TH SEPT BEFORE 2 DN

DISMANTLE M.G. & LINK B.G. : 3. 36 75LBS 4 RAILS

M.G. CROSSING TO BE DISMANTLED & SUBSTITUTED BY SINGLE RAIL FOR PASSING M.G. TRAINS

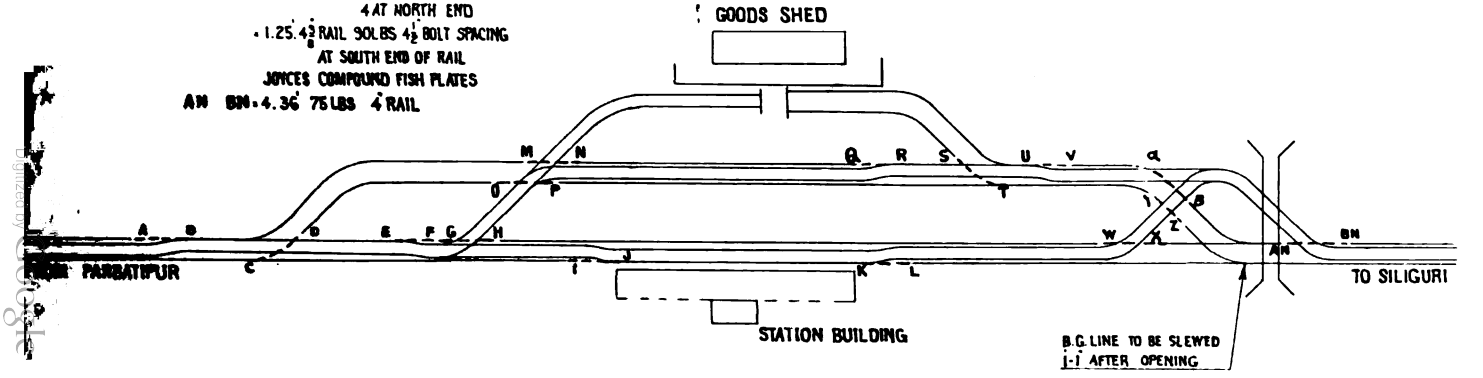
O P : 3. 36 75LBS 6 RAILS

M N : 3. 36 " " "

Q R : 1. 36 " " "

S T : 1. 29. $9\frac{1}{8}$ " " "

U V : 1. 36 6 BOLT SPACING RAIL



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Arrangements for the Change Over.

By the beginning of September the main line had been linked through, there were gaps only at station yards. The plan of Daroani station yard shows what was left to do at each of the nine stations.

Instructions for the staff were then issued, and an officer or senior subordinate was detailed for each station. He was also made responsible for the track in the down direction between his station and the next. A copy of the instructions issued to the staff at Saidpur and Daroani Stations is attached to this paper (Appendices II and III).

The date fixed for opening the new line was October 1st. The line had first to be inspected by the Senior Government Inspector of Railways, and his inspection was arranged to start from Saidpur at about 07.00 hours on September 30th. The section Parbatipur to Saidpur had been passed previously.

All traffic was cancelled for one day only, and the following extract from the traffic circular gives details of the arrangements made as regards passenger trains and coaching stock. Goods traffic had been previously curtailed, and by September 28th no metre-gauge goods vehicles were left on the section.

Passenger Train Arrangements in Connection with the Opening of the Broad-Gauge to Siliguri.

The Actual Conversion from Metre-Gauge to Broad-Gauge will take place between the passage of 2 Down Mail (Metre-Gauge) on September 29th and 37 Up on September 30th.

The last Metre-Gauge train to run over the Section Siliguri–Parbatipur will be 2 Down Mail leaving Siliguri at 15.30 hours on 29th September. A special with the rake of 13 Up will run from Siliguri to Parbatipur in front of 2 Down to the following timings :—

Stations	D Rake of 13 Up.	Stations.	D Rake of 13 Up.
	H. M.		H. M.
Siliguri ... ... Dep.	14 ... 20	Domar ... ... Arr.	...
Belakoba ... ... Arr.	...	Dep.	17 ... 31
Dep.	15 ... 6	Nelphamari ... Arr.	...
Jalpaiguri ... ... Arr.	...	Dep.	18 ... 4
Dep.	15 ... 37	Daroani ... ... Arr.	...
Mandalghat ... ... Arr.	...	Dep.	18 ... 24
Dep.	15 ... 58	Saidpur ... ... Arr.	18 ... 50
Haldibari ... ... Arr.	16 ... 22	Dep.	19 ... 0
Dep.	16 ... 32	Belaichandi ... ... Arr.	...
Chilhati ... ... Arr.	...	Dep.	19 ... 15
Dep.	16 ... 58	Parbatipur ... Arr.	19 ... 36

After the passage of 2 Down Mail, the Line will remain closed in the hands of the Engineering Department, until it is opened as Broad-Gauge on September 30th.

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The first BROAD-GAUGE train to run over the Section will be 37 Up leaving PARBATIPUR at 15.40 hours on September 30th and running to the present Metre-Gauge timing.

The trains running between PARBATIPUR AND SILIGURI on the 29th, 30th September and 1st October will be as follows :—

September 29th.

15 Up, 1 Up, 13 Up will run as usual.
37 Up will be CANCELLED.
14 Down and 2 Down will run as usual.
16 Down and 38 Down will be CANCELLED.

There will be NO UP THROUGH SERVICE leaving Calcutta on SEPTEMBER 29TH and NO DOWN THROUGH SERVICE leaving Siliguri on SEPTEMBER 30TH.

The Down special with the rake of 13 Up arriving at PARBATIPUR at 19.36 hours will work forward to KATIHAR at 20.6.

The rake arriving PARBATIPUR as 14 Down at 12.25 hours will be worked forward to KATIHAR as an empty stock Special at 13.30 hours.

The rake arriving PARBATIPUR as 2 Down at 20.17 hours will be worked forward to LALMANIRHAT as an empty stock Special at 21.10 hours.

The Siliguri-Amingaon through carriage will go forward to Lalmanirhat by the 21.10 hours Special and be transferred to 3 Up Mail at Lalmanirhat.

September 30th.

ALL TRAINS CANCELLED.

Except 37 Up BROAD-GAUGE which will run through to SILIGURI to the present METRE-GAUGE timing leaving PARBATIPUR 15.40 hours and arriving SILIGURI 21.40 hours.

AN ENGINEER'S SPECIAL will leave SAIDPUR at 7 hours. This train will be an Engineering train and will NOT be worked on Line Clear. DIVM and DLR will accompany this train which will be made up as follows :—

Bogie Brake and Third.
Bogie Third.
Bogie Composite.
Saloon 1010 for Dy. CE.
CE's Saloon No. 1409.
AGE Saloon.
SGI's Saloon No. 1410.
Saloon 1009 for SE and ASE.
Saloon 2 for DIVM and DLR.
Saloon 148 for XEN and SDO.
Luggage Van.
Luggage Van.
Brake-Van, 4-wheeled.
Inspection Saloon 1411.

This train will be made up at PARBATIPUR and leave for SAIDPUR at 6.30 hours working on Line Clear to SAIDPUR.

The LINE will be opened as BROAD GAUGE, Section by Section, after the passage of this Special. The OPENING messages will be issued in accordance with the SGI's orders by XEN, SDP who will travel with this Special on the Agent's instructions. Restrictions in speed below 25 miles per hour will be imposed as Restrictions on Working Time Table No. 129 already issued.

Two Light Engines (coupled I. class) will follow the Special as soon as

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the line is opened and WILL WORK on LINE CLEAR (NEALE'S TOKEN). These Engines will be in the charge of an Engineering Department Official who will accompany them from Saidpur to Siliguri.

The Engineering Special will be stabled in the Loco. Yard at Siliguri on arrival.

October 1st.

TRAINS WILL RUN TO THE NEW TIME-TABLE except that 15 Up (6.20 hours PARBATIPUR to SILIGURI) and 22 Down (9.36 hours SILIGURI to PARBATIPUR) WILL NOT RUN.

AN UP GUESTS SPECIAL IN connection with the Inaugural Ceremony at SILIGURI will leave CALCUTTA 20.56 hours on 30th and run from PARBATIPUR at 4.33 hours on 1st arriving SILIGURI at 9.45 hours.

An Up Empty Stock Special (rake arriving PARBATIPUR as 13 Up 3.26 hours on 30th) will leave PARBATIPUR 9.15 hours arriving SILIGURI 14.55 (after crossing Down Guests Special at BELAKOBA) to work 16 Down. This rake will be strengthened by 1 BC before leaving CA as 13 Up on 29th.

The Down GUESTS SPECIAL will leave Siliguri at 13.20 hours and arrive PARBATIPUR 18.7 hours leaving at 18.17 hours for CALCUTTA.

37 Up will be detained at Jalpaiguri to cross the Down Guests Special and at BELAKOBA to cross 16 Down.

As 2 down mail cleared each section of the line, the line was taken over by the Engineering Department, and gangs immediately got to work. The last station to be taken in hand was Saidpur at 20.00 hours.

Saidpur was ready for inspection at 7 hours on September 30th, and the inspection special left at 7.30 hours. By this time telegrams had arrived from every station to say that the main line had been linked through, and that a crossing loop was available also at practically every station. The line was declared open for traffic when the special arrived at Siliguri at about 15.30 hours, and the first train left Parbatipur at 15.40 hours.

The time taken to organize the change over was well spent, as there was no hitch anywhere. At Saidpur there was a slight miscalculation, the rails for joining up had been measured by day, and an allowance for contraction was made by slotting the fish plates; however, when the work came to be done it was found that the allowance was not quite sufficient. This was soon rectified.

The conversion was formally completed and opened to traffic by Sir George Stephenson, H.E. the Governor of Bengal, the following day, October 1st, 1926, by a small but impressive ceremony, to witness which many guests had been invited from Calcutta and Darjeeling.

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APPENDIX I.

TIMING OF BALLAST TRAINS.

UP.

Stations.	*Miles.*	*Minutes run.*	"A."	"D."
Parbatipur ...	...	... ...	Dep. 1.15	13.00
	4½	27		
			Arr. 1.42	
Belaichandi ...	...	... ...	Dep. 2.00	Pass 13.27
			x 544 Down	
	4	24		
			Arr. 2.24	
Saidpur ...	...	... ...	Dept. 3.00	Arr. 13.51
			x 16 Down	Dep. 14.06
	7	35		Water.
Daroani ...	...	... ...	Pass 3.35	Pass 14.41
		27		
			Arr. 4.02	
Nelphamari ...	...	... ...	Dep. 4.30	Pass 15.08
			x "C" B.T.	
	10	44		
Domar	...	... ...	Pass 5.14	Pass 15.52
	10	43		
Chilhati ...	...	... ...	Pass 5.57	Pass 16.35
		32		
			Arr. 6.29	Arr. 17.07
Haldibari ...	...	... ...	Dep. 6.39	Dep. 17.27
				x 2 Down
		34		
			Arr. 7.13	Arr. 18.01
Mandalghat ...	...	... ...	Dep. 7.28	Dep. 18.10
			x 14 Dn.	x 224 Dn. and
		43		"B" Dn.
Jalpaiguri ...	...	... ...	Arr. 7.59	Arr. 18.41
				Dep. 19.36
				Precedence to 223 Up
				and 544 Down.
Belakoba ...	...	... ...	... ...	Pass 20.19
Siliguri ...	...	... ...	... ...	Arr. 21.12

"A" is for a linking train due to distribute sleepers, rails and fastenings, leaving Parbatipur fully loaded.

"D" is the empty stone train returning to Siliguri.

In addition, any Up B.T. running between sections had to take up these times so that B.T.s always ran to special times.

TIMING OF BALLAST TRAINS.

DOWN.

Stations.	*Miles.*	*Minutes run.*	"B."	"C."
Siliguri ...	...	... ...	... ...	Dep. 23.05
		53		
Belakoba ...	...	... ...	... ...	Pass 23.58
		43		

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Stations.	*Miles.*	*Minutes run.*	"*B.*"	"*C.*"
Jalpaiguri			Dep. 17.05	Pass 00.41
		31		
			Arr. 17.36	
Mandalghat			Dep. 18.04	Pass 01.12
			x " D " Up.	
		34		
			Arr. 18.38	Arr. 01.46
Haldibari			Water	xUp Goods
			Dep. 18.48	Water.
		32		Dep. 01.56
			Arr. 19.20	Arr. 02.28
Chilhati			Dep. 20.05	Dep. 03.00
			x 37 Up.	x 15 Up.
		43		
Domar			Pass 20.48	Pass 03.43
		44		
			21.32	04.27
Nelphamari			x Up Goods	x " A " Up
		27		
Daroani			21.59	04. 54
		35		
			Arr. 22.34	
Saidpur			Water	05.29
			Dep. 22.44	
Belaichandi			23.08	
		27		
Parbatipur			23.35	

" B " is for linking train to return to Parbatipur.

" C " is for loaded stone train to run out from Siliguri to distribute ballast.

Any other trains running on the section run to these times if no linking or stone train is running.

APPENDIX II.

Eastern Bengal Railway.

Saidpur Station Yard.

Work will be done on 29th September as per ferro.

If necessary 13 Up can be dealt with on Main Line.

DIVM's Saloon will leave 8 down siding by 2 Down of 28th, so that points of siding can be dismantled and G.H. linked on 29th morning.

All other trains will be dealt with on Main Line. M.G. points to be clamped, locked and spiked for Main Line.

Work should be finished by 12 hours. Break off for rest and commence work again at 19.30 hours, and complete yard as per ferro.

Ferro explains itself.

AEE/SDP is kindly arranging for lights.

Mr. Rogers is in charge.

He will join the Special on the morning of 30th at S.D.P. at 7 hours with 200 coolies with tools, etc., and 10 sets of restriction boards (SEN has orders for these) in case he is wanted on the line. He must be prepared to stay out one night.

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APPENDIX III.

EASTERN BENGAL RAILWAY.

DAROANI STATION AND TRACK D.W.N.—S.D.P.

Sept. 25th. Mr. S. K. Bhattacherjee will take post. (S.D.O. Cons. will send you a Swiss cottage tent).
Assure yourself that labour is present and has tools.
See that all fouling marks are in correct position.

Sept. 26th. Detail labour to works by names of mates for 29th and 30th, and make them do their jobs under a block, and note time taken and what unforeseen circumstances are encountered.
Then restore M.G.

Sept. 27th. Pack up facing points and loop.
Trolley to Saidpur and back.
Carry on linking B.G. goods if space is available.

Sept. 28th. Carry on linking B.G. goods and see Main Line.

Sept. 29th. Commence work at 7.30 hours.
Clamp, spike and lock M.G. points for the Main Line, keep keys of locks yourself. All M.G. trains will be dealt with on Main Line.
See ferro for work to be done.
Pack up and finish off work properly.
You should be able to break off about 12 hours.
Allow men to rest until 19.00 hours. See that they have their meal before returning to work at 19 hours.
Immediately 2 Down Mail has passed dismantle M.G. and complete the B.G. yard. You should be able to do this in 3–4 hours.
Clamp and lock B.G. points for B.G. Special to run through on Main Line.
I have arranged for four Storm King Lamps for work at night; you had better have some flares too.
Whitewash fouling marks again.

Sept. 30th. If yard is complete send out a man to Up Outer Signal with Green Hand Signal Flag. If yard is not complete send out a Red Banner Flag.
I hope we see the Green Flag when we arrive at about 7.30 hours.
Pack up any soft places found by Special.

Oct., 1st, etc. Complete Yard in all respects.

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CHARACTERISTICS OF A GOOD LESSON.

By LIEUT. F. C. C. BRADSHAW, R.E.

INTRODUCTION.

Training and Manœuvre Regulations state: "An Officer's first duty is to be a capable leader in war. *But it is almost of equal importance that he should be an efficient instructor in peace . . .*"

Many officers instruct their men by practical work in the field, supplemented by lectures indoors. *Training and Manœuvre Regulations* give hints on how to carry out a lecture, but the writer is of the opinion that a far better means of giving instruction to men is by means of a *lesson*.

In a lecture, the officer normally tells the class certain facts and probably gives the reason for such facts. In a lesson, the students are encouraged to find out facts and solve problems by reasoning for themselves. In these days, in which it is generally recognized that modern warfare demands intelligent co-operation on the part of N.C.O.s and men in place of the old blind discipline, it is imperative to develop the reasoning power of the soldier to its fullest extent, and to teach him how to acquire knowledge for himself without always relying on someone else to help him. A lecture can never do this.

It may be argued that the time required to prepare and conduct a lesson is more than that required for a lecture and that more ground can be covered by the latter, in any given length of time. If, however, the lesson be conducted efficiently, the instruction will undoubtedly be better absorbed and will avoid the necessity for frequent repetition, and, on the whole, time will be saved rather than wasted. In addition to the mere absorption of knowledge in every lesson, the mental capacity of the students is being increased.

With these points of view in mind, the writer submits the following notes on the characteristics of a good lesson, feeling that, although they are merely commonsense and of a somewhat elementary nature, they may prove of interest to officers who have not considered very deeply the question of a delivery of a lesson as opposed to a lecture and may provoke criticism and discussion from others.

Although, in these notes, the conduct of a lesson in a classroom is primarily discussed, the principles that the writer has in mind are equally applicable to all forms of instruction, whether carried out indoors or in the field, and whether the subject is of a practical or theoretical nature.

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DEFINITION OF A LESSON.

First of all, it is necessary to be quite definite as to what a lesson is. A lesson is an attempt on the part of a teacher to make his students absorb a piece of knowledge in such a manner that they can thoroughly appreciate it, and use it intelligently in problems which may confront them. The more fully this is done, the better will be the lesson.

PROBLEM BEFORE THE TEACHER.

The problem before a teacher is how best to transmit a certain piece of knowledge to a certain class of students, within a certain limit of time, and ensure that this piece of knowledge really becomes part of their own knowledge, and is not merely accepted as true by the students, because he has told them so. Considering ourselves as teachers, let us think out the best method of solving this problem, and so arrive at what the essentials of a good lesson must be. We have decided what is required of us. What are the factors affecting the conduct of a lesson? The teacher himself, the piece of knowledge to be transmitted, the mentality of the class and the time allowed for the lesson. Bearing these four factors in mind, how is a teacher to set about his task? Firstly, he must prepare his lesson, secondly, he must deliver it to his class, and lastly, he must satisfy himself that the class has absorbed the knowledge required. Let us discuss the essentials of the lesson under these heads, namely, Preparation, Delivery and Benefit to the class.

PREPARATION OF LESSON.

What are the essentials in preparation? The teacher must firstly take steps to acquaint himself with as much knowledge as is necessary (always far in excess of the knowledge to be passed on to the class) of the subject he proposes to teach. Furthermore, he should ensure that it is accurate and is likely to be beneficial to the type of student he is teaching. From the information at his disposal, he must now, having in view the time allowed to him and also the mentality of his class, fix firmly in his own mind a very definite conception of exactly what he proposes to teach. He then must decide how best to do this. He should try, whenever possible, to present his lesson in the natural form in which the problem is likely to arise in real life. For example, if he is teaching how to find the area of a rectangle, he must give some example to his class which will make the class realize the necessity for wanting to find the areas of rectangles in everyday life. Throughout the lesson, he must try and arrange a series of problems in a natural and logical order for the class to solve. These problems must be so arranged that the class can solve them with a reasonable amount of thought within a reasonable time. The steps or series of

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problems must be such that it is not too big an effort for the mentality of the class to bridge the gap between them.

While arranging these problems for his class to solve, the teacher must remember the exact purpose of his lesson. He must think out what questions are likely to arise in the minds of his students, and how best to answer them. He may have to explore by-ways and decide whether to accept or reject them. He must decide what to include and what to exclude from his fund of knowledge. He should now rehearse his lesson, bearing in mind his particular faults and making use of his good points as a teacher. As a result of his rehearsal, he may find faults in his proposed lesson. A frequent fault will be that of over-estimating the amount of work that can be got through in the allotted time. After having altered his proposed lesson as necessary and after further rehearsal (if required), he must then finally decide on the matter of his lesson and the method of giving it to his class. He must then take steps to ensure that all the necessary materials for himself and his class are available for use when he comes to the delivery of his lesson.

Delivery of Lesson.

We will now suppose that the teacher, having very thoroughly prepared his lesson, with due regard to the subject, mentality of his class, and the time factor, and being quite self-confident and sure of what he wishes to do, is now faced with his class and is about to start his lesson. If such a thing were possible and his preparation had been perfect, if he had a perfect idea of the mentality of every member of his class, and knew exactly his own personality as a teacher, then his delivery should follow exactly along the lines of his preparation. Obviously, of course, this cannot happen in practice. However thorough the preparation, the class is bound to behave differently to the manner in which the teacher assumed it would. Someone will be unusually stupid, someone else asks an unexpected question. Someone else is tired after a dance the night before. Other distractions may be present besides these. The room is cold. It is the last lesson of the week, and so on. The teacher must, therefore, be prepared for unforeseen eventualities, and must be able to adjust his lesson to the needs of the moment.

What must the teacher do first, when he commences his delivery? He must appeal to the interests of the class. He must obtain their attention and hold it. He must, therefore, start his lesson with something which is familiar to them, of interest to them, and which they can readily understand. By this means, he has attracted their attention and interest. He must now continue to hold it. He must ensure that, as far as possible, the class enjoys the lesson. At the same time, he must see that the class is obtaining the knowledge

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required. Both these ends can be obtained by (as already stated in the preparation of the lesson), getting the class to discover facts for itself, to reason out the whys and wherefores, to arrive at correct conclusions, under the guidance of the teacher.

The lesson should unfold itself in an apparently natural manner. The class should be surprised by the very simplicity of the subject it is investigating. The class must, in fact, work hard quite unconsciously. Every effort must be made to appeal to the eye by the use of sketches and summaries on the blackboard, by maps, photographs, pictures and models. These sketches, etc., should be presented to the class at the precise moment they are required, and should not be in view of the class before that moment or the attention of the class will be distracted by them.

The class must have confidence in the teacher. It must like and respect him. The teacher can only hope to achieve this by having a thorough knowledge of his subject, and a true understanding of the difficulties of his students and a real desire to help them. At the end of a lesson the teacher should gather up the threads of the lesson into one harmonious whole, and "tidy up the mind" by means of a clear and concise summary of the main points of the lesson. Should the teacher find that he is unable to cover the amount of ground that he had hoped, he must never try and cram the remainder of his lesson into the last ten minutes. He must merely break off at the end of one of his intermediate steps, gather up the threads of the lesson, as far as it has gone, by a summary and always leave himself time to ask questions on what he has had time to teach. He can then carry on in his next lesson at the point where he left off.

BENEFIT OF LESSON TO CLASS.

After his delivery, the teacher must satisfy himself as to what extent the class has benefited. He can do this by means of questions and problems necessitating an application of the matter he has been teaching. If the lesson has really got home, the members of his class will talk about it to him, and amongst themselves, long after the lesson has been taught, and this is the real test of the benefit of a lesson.

The personality of a teacher when delivering a lesson, his powers of description, his illustrations, his ability to paint vivid pictures, all help greatly towards the impression a lesson makes upon a class.

SUMMARY OF THE CHIEF CHARACTERISTICS OF A GOOD LESSON.

Having now discussed the three aspects of a lesson, let us try and summarize the essential points of a good lesson. They appear to be:

(1) *Thorough preparation on the part of the teacher, ensuring that:*

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(a) The aim of the lesson is absolutely clear.
(b) Unnecessary matter is rejected.
(c) Matter of lesson is within average intelligence of the class and likely to be beneficial to them.
(d) Matter is presented in simple, clear and logical form, and when possible in the shape of a series of problems of gradually increasing difficulty, to be solved by the class without conscious effort.
(e) Subject is taught within allotted time.
(f) All necessary apparatus is present.

(2) *Delivery of lesson to be such that :*
(a) Attention of class is attracted by commencing lesson with something familiar and known.
(b) Class enjoys lesson and proceeds by a number of easy steps as outlined in (1)(d).
(c) Class has confidence in and respect for the teacher.
(d) Class has a clear and concise summary of the lesson presented at the end.

(3) *Benefit from lesson is ensured by :*
(a) Questions and problems set by the teacher.
(b) Encouragement by the teacher for further discussion by the students.
(c) Teacher using his own personality to make as vivid an impression on the class as possible.

Illustration.

In the foregoing notes, it has been stated that the teacher should try and arrange a series of problems in a natural and logical order for the class to solve. It is thought that perhaps an example would help to make the writer's meaning clearer as to what is meant by this.

Suppose the subject to be taught is *the meaning of a scale and the necessity for a scale line and its use on* 1-*in. and* 1/20,000 *maps.* The class can be considered to be composed of normal candidates for Second Class Certificates of Education, and to be conversant with conventional signs on both these maps. It is improbable that the above matter could be taught to such candidates in one lesson, but for the purposes of illustration, this amount of matter has been chosen as it shows a fair number of steps. Any lesson could be broken off at the end of any one step, and be taken up at that point in a later lesson.

Step one.—The students are given some simple object such as a match box or an ink pot, and asked to draw a plan of it. This is readily done by tracing round the outline of the object placed on a piece of paper.

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Step two.—How is anyone to know what the plan represents? Students write above the plan "PLAN OF MATCH BOX." What is the size of the plan, compared with the actual object drawn? Students realize it is full size and write down under the plan "FULL SIZE DRAWING."

Step three.—The students are then asked to draw a plan of a square box or rectangular object larger than the piece of paper they are provided with. Then they realize the necessity of drawing a plan to some scale. Various members of the class may provide various suggestions—to draw it half size or quarter size. Class must be got to realize that if a drawing is made so that the area is quarter size, the linear measurements are half the measurements they represent. Class is then told that scales for maps are spoken of in terms of linear measurement.

Step four.—Students then draw a plan of the classroom in which they are seated, both on paper and on the blackboard. This shows that drawings can be made to *different* scales of the *same* object. Students are asked to measure the diagonal of the room. Some may measure it in the actual room, brighter students will measure the diagonal from the plan drawn and from that determine its length.

Succeeding steps.—Get class to realize the necessity for every plan having a written statement of what the scale is. Then to realize the necessity for calculation with a written statement, in order to measure any length from the plan. Class is asked to suggest how calculation could be avoided and how lengths might be arrived at more quickly from the plan. Class should be able to appreciate the advantages of a scale line to save calculation and to provide an automatic ruler. Students construct scales for their plans. Development of openly-divided scale from the fully-divided scale is then shown. Measurements are then carried out on the 1-in. and 1/20,000 maps, using the openly-divided scale. Distances are measured first as the crow flies. Class is invited to suggest how to measure roads with bends in them. Solution is evolved and plenty of practice given. Later, marching problems, etc., can be introduced involving the application of measurement by scales.

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CHITRAL.

Passing ladders on the road in Chitral.

The Chitral road and river (in flood) at dawn.

The advanced guard. Q.V.O. Corps of Guides and K.G.O. Bengal S. & M.

The old bridge and fort at Ghairat, built in 1890 and looted for firewood by Chitralis. New bridge has recently been built.

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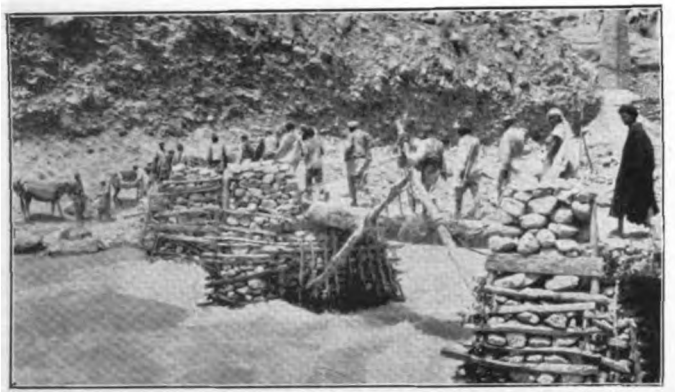

Swatis crossing temporary bridge, Mastuj. Piers of new bridge in background.

Swati caravan crossing temporary bridge, Mastuj.

Junction of the Chitral and Lutkoh rivers.

View up the Chitral river from Drosh.

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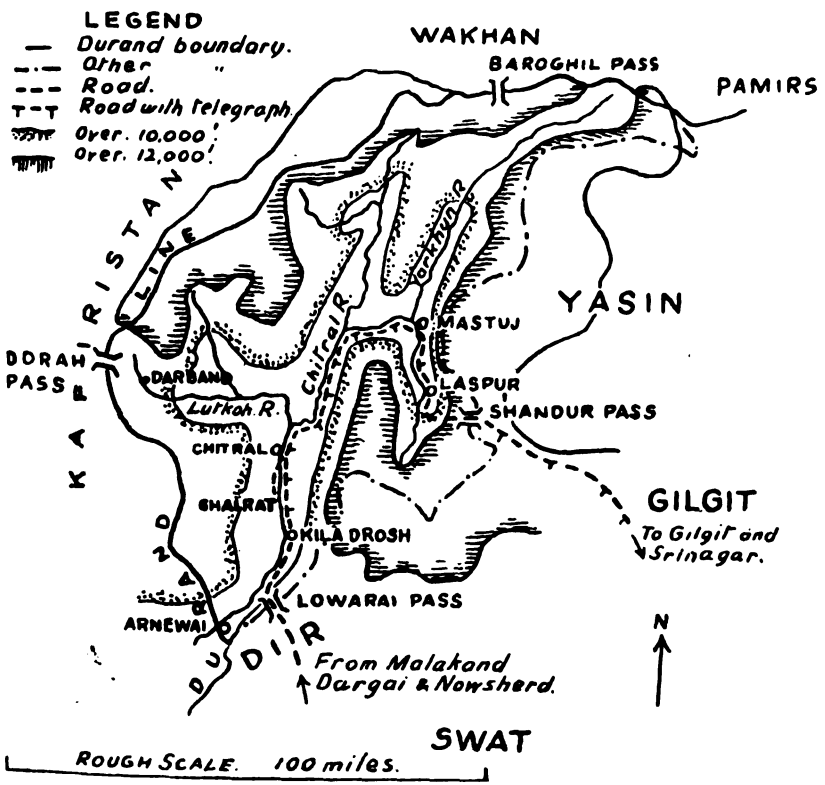
CHITRAL.

By INGENIATOR.

THERE can hardly be a country in the world so strangely isolated as Chitral. Situated in the centre of the largest land mass on the globe and in the temperate zone, it is yet almost entirely cut off by natural features and local conditions from intercourse with its neighbours.



It is nearly unknown, and has probably been heard of only by those who follow the minor and madder activities of the British Army. I was so fortunate as to be ordered there on temporary duty in 1926, and I found the trip so enjoyable that there may perhaps be some interest in it for others.

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To describe Chitral fairly would require a vocabulary as prolific as Shakespeare's and as apt as Milton's. One can only deplore the inadequacy of calling the country mountainous; it has been torn and twisted, slashed and shivered by nature in a frenzy. Such a hopeless tangle of abysmal valleys and unattainable heights must be seen to be realized.

In shape it is roughly an oval 180 miles long and 80 miles broad, with its major axis lying N.E. and S.W., and it covers the catchment area of the Chitral River, which flows down to join the Kabul River away south in Afghanistan. It lies right beyond the Pathan country, and its inhabitants form a race of their own. To the south, at the head of the Panjkora valley, lies the country of the Nawab of Dir. To the south-west and west is an outlying and little known district of Afghanistan called Kafiristan; to the north is the Wakhan—that narrow strip of land ceded to Afghanistan to perfect its buffer effect and ensure that British and Russian territory should nowhere meet; east is Yasin, which leads to Gilgit and from there far south by Astor and Baltistan to the plain of Kashmir.

The boundary on all sides is mountain, and, except at Arnewai, where the Chitral River has its exit, is probably nowhere lower than 10,000 feet. The routes across this boundary can be counted on the fingers of one hand. The Lowarai Pass (10,000 feet) is the entrance of the main route from India which leaves railhead at Dargai (50 miles from Nowshera), crosses the Malakand Pass, and traverses Swat and Dir for about 80 miles from Dargai to the Lowarai. The pass is open to pack transport for four months of the year, but for the rest is closed by snow. In the winter, only the expert local mountaineers can cross it at the risk of their lives, and letters are sometimes held up for three weeks.

The next gateway of the country is Arnewai; this is the only approach which does not lie across a mountain range. It leads into Afghanistan, which is as good as saying that there is little trade or traffic on it. There is an Afghan military post at Arnewai.

The third gateway is the Dorah Pass on the west side leading into Afghanistan. It has no made track of any sort across it, and warrants no further mention.

The fourth is the Baroghil Pass on the north, which leads into the Wakhan. It is used by traders' caravans going to Kashgar and Yarkand about once a year.

The last gateway is the Shandur Pass, on the east, leading into Yasin. This is the pass used by the first British troops to enter the country—the Gilgit garrison under Lieut. Fowler, R.E., in the relief of Chitral. It has a track of sorts across it, and takes the telegraph line to Srinagar. There is no line over the Lowarai, as it would stand little chance of life in the Pathan country the other side.

The routes in Chitral are really confined to one—the main artery of

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the country. A pack road, with suspension bridges maintained by the Government of India, leads from the Lowarai up the Chitral River, connecting the main villages—Kila Drosh, Chitral, Mastuj, Laspur and the Shandur. A few short routes leave this and wind up side valleys to other villages. Between Drosh and Chitral this road is quite good, and it would almost be possible for a stout driver to take a Ford along it. The Mehtar of Chitral has been encouraged to bring up a car in bits from India and have it assembled at Drosh for this purpose, though I have not heard that the feat has been accomplished. If it were, the Mehtar might be induced to maintain the road himself.

A walk along this road is nothing if not awe-inspiring. A brown waste of tortuous mountain so steep that in places one has to crane one's neck to see the sky; the foreground a welter of gnarled and knotted crags; at quarter-mile intervals a tuft of grass or a splotch of moss; and below, the roaring of the river. At one point above Chitral the road across a precipice is so narrow that ladders are provided for passing. When two parties meet, the ladder is stood against the rock and one man climbs the ladder while the other passes beneath him.

Suddenly one swings a corner round a rock, and there before one, not a hundred yards away is a green and sheltered village. All the side *nullahs* bring down debris, which collects where it debouches into the main valley as a "fan"; on these fans the *nullah* water can be spread by digging channels, and here the villages spring up. And they are most fertile. Wheat, rice, maize all growing in profusion. Most wild flowers indigenous to England are found, but best of all is the fruit. Apricots, mulberries, melons and peaches grow naturally. Apples, pears and plums can be imported with success.

The apricots are almost a staple food of the country. The village houses are well made and comparatively clean. The natural supply of most excellent iced water is limitless.

Of the villages, Chitral is the largest, and there the Mehtar has his palace, the Assistant Political Agent his house, and the Scouts their headquarters. There is quite a large bazaar. The only other bazaar in the country is at Drosh—25 miles downstream—and it is here that the Chitral garrison is cantoned. Mastuj has a Post Office, the last and most northerly mark of the British Raj in Central Asia. The garrison consists of one battalion of Indian infantry, of which one company is on detachment in Chitral, one section of Sappers and Miners, and a section of guns. The battalion, the Pack Section, R.A., and a hospital, are quartered up in the fort. Two Sappers and two I.A.S.C. officers live in lower Drosh in a "chummery" with a pretty garden. The Chitral Section, K.G.O. Bengal Sappers and Miners, have their lines here, but as they are the only part of the force that has the run of the country they are seldom there. They prefer to be

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away on their own on the road, generally repairing or rebuilding the many suspension bridges.

One might justifiably ask why is a garrison maintained up there in such an outlandish spot; for the country is too terrific to be possible as a route of invasion of India. Yet since the insurrection of 1895 the garrison has always been there. It is kept up for various reasons, of which the chief are three. First, the garrison removes the possibility of further local trouble. The Chitralis are a murderous, patricidal race. Secondly, if we were not there, someone else might be. Thirdly, it forms a useful and very advanced feeler towards an area of foreign development in Central Asia which has given us more than one *mauvais quart d'heure*, and it lies on the flank of any possible operations near Kabul.

The history of Chitral before the war in 1895 is untraceable. On the war several books have been written—all of entrancing interest and well worth reading. The Chitralis themselves are Mussulmans of a very degraded type. There are both Shiahs and Sunnis amongst them. And there is a tribe of Kafirs (divided into red and black Kafirs) who practise pure demon worship. The red Kafirs hold a yearly feast in their head village which takes the form of a mystery play, and the theory has been advanced—not unknown in other parts of Asia—that the red Kafirs are a relic of Alexander's lost army. The king of Chitral is known as the Mehtar, and the native language is one of the many derivatives of Persian and is known as Kohar.

As each village, almost each house, is entirely self-supporting, there is no trade in the country. But I was fortunate in seeing something of a caravan of Swati traders who use this route to get up to Kashgar and Yarkand. Swatis are looked upon by other Pathans as the buffoons of the frontier. This caravan had 475 mules, which they had loaded up in Peshawar. The S. and M. were at Mastuj, building the new suspension bridge, and as the only crossing was a very *kacha* footbridge of poles in a precarious condition, the Swatis had to unload their mules and halve the loads. Each half was then manhandled over. It took them three days to cross. Their goods were mostly spices, *charas* and trinkets. Each man had a monkey, as they said monkeys were fashionable as pets amongst the ladies of Yarkand. They expected to bring back tea, *numdahs*, skins and ponies.

Some would consider Chitral an ideal station, and some would consider it otherwise. Once there, you are there for two years, though possibilities of leave to India are increasing. Two months' leave can be spent in the country on *shikar*, but the new landing ground just built in Drosh will enable officers to get down to India in a day, though the R.A.F. like nothing less than flying to Drosh. Once they have left Chakdara, they have nowhere to land but Drosh, and if they lose their way a crash is a certainty. But there are other ways. There is a true story of the old minister of the country who

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went from Chitral to Srinagar in 48 hours by sheer hard riding and good *bandobast*.

Of sport there is hockey, football and tennis. There may even be squash there now. The chikor shooting is the finest in the world, and there are small ibex and markhor. There is a better chance of snow leopard (always a matter of chance) than anywhere else in the Himalayas. There is no fishing. If enough players can be collected, there is polo in Drosh. Failing that, one can always play Chitrali polo. I saw one game of this while I was there. It lasted 40 minutes without a stop: players cut in or out as they felt inclined, but most ponies played the full time; play is unencumbered by any rules or referee, and is started by the two sides lining up at either end of the ground and charging for the ball. The sides of the ground are conveniently provided with boulder walls two feet high, off which some clever cushion shots are taken. A country band plays throughout the game, and the losers have to dance to it after the game for the regalement of the winners.

Chitral is a fine country, and most people who have spent two years there, though they may have felt their activities somewhat curtailed, look back on the time with pleasure.

Editorial Note:—R.E. Professional Paper VI of 1896 gives a lot of information about the bridging operations during the 1895 Relief Expedition.

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ANCIENT LAND MEASURES OF BRITAIN AND MALTA.

By COLONEL J. W. S. SEWELL, C.B., C.M.G.

IN the period 2500 B.C. to 2000 B.C., the western half of Britain was invaded by a maritime race, coming from the South, in search of tin.

Malta also was first occupied by a branch of this Eurafrican race.

We might reasonably then expect common factors in weights and measures indicating a common origin, subsequently diversely affected by the influence of Asiatic culture. It must also be remembered that, in those days, there was little arithmetical science, and that land divisions must perforce have been made with the aid only of geometry and probably standard rods. The original measures in use in Malta appear to have been :

*Linear :** 1 Canna = 8 Palmi ; 2 Canne = 165″

Surface : 1 Salma = 4 Weiba = 16 Tumoli
= 16 × 256 square Canne.

It will be observed that the multipliers are all powers of the prime 2. The introduction of the primes 3 and 5 will have been due to Asiatic influence ; and thus we find the tumolo divided into 6 mondelli = 60 misure.

The British land measures are convertible as follows into Maltese units :

1 Acre = ·9 Weiba.
1 Rood = ·9 Tumolo.
1 Rod = 1·35 Misure.

There thus appears a suggestion that the Weiba is the original Eurafrican unit of land measure, but it is obviously necessary to seek an explanation of the reduction of this measure by one-tenth, so as to arrive at the acre.

The following explanation is purely speculative, but may be regarded as consistent with what is known of early systems of government, and the limitations imposed in those days by the lack of arithmetical science ; it is also suggested by the curious fact that the Maltese units of land measure given above are actually units of capacity. Thus the Salma is 1 Quarter (of corn), and the area of 1 Salma is the area theoretically required to produce 1 Salma of corn. It is, therefore, suggested that the original taxation took the form of

* In these Tables the modern Italian names are used in lieu of the true Maltese names, owing to the fact that the former are the names officially employed.

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a tax on capital values. So that a farmer had to yield to the State, not a proportion of his crop, but a definite number of bushels of corn per Weiba held by him. Under the stable conditions of cultivation in the Nile Valley, for example, this would be a reasonable form of tax, inasmuch as it was simple to assess and gave a fixed revenue to the State. The only difficulty would arise in years when the Nile flood was abnormally low. Thus we find Joseph advising Pharaoh to "take up the fifth part of the land in the seven plenteous years." For "land," we may clearly substitute "crop"; the advice probably involved two changes in the system of taxation:

(*i*) A substitution of an income tax in lieu of the tax on capital values, so as to obtain the benefit of the richer crop per Weiba.

(*ii*) Doubling the tax, from the normal tenth to one-fifth, to meet the subsequent years in which no revenue could be expected; owing to the richer crops, this increased assessment would be tolerable.

However that may be, it would appear that neither a tax on capital values, nor an income tax on crops, would be suitable for Britain; the former on account of the unstable climate, resulting in too wide differences in annual crops; the latter owing to the openings it gave for cheating the revenue. In consequence, when a State church was established, it was provided with a revenue by means of the third course open, viz: a capital levy, by which every landowner ceded to the church one-tenth (a "tithe") of his holding. Arithmetically, this meant that from the "Weiba" of 48,400 square feet, the Church took 4,840 square feet, and the landowner retained 4,840 square yards, that is, one acre. Geometrically, division was simple, inasmuch as the "Weiba" contained 100 plots of 22 feet by 22 feet.

Thus 1 Weiba $=2^{16}$ sq. palmi; or $2^2 \times 10^2 \times 11^2 \times 12^2$ sq. inches.

These land measures, of course, involve the use of standard lengths; we have then to consider:

(*a*) The British standard inch, and the somewhat anomalous linear rod of 16½ feet. This rod contains 198 inches, and is, therefore, divisible by 11. A rod divided by 16×12 would give a small unit of 1·03125″.

(*b*) The Maltese canna, which contains 8 palmi: 1 palma = 10·3125″; this, divided by 10, would give the same, 1·03125″.

(*c*) The long foot of 12·5225″, to which Sir Flinders Petrie has drawn attention; dividing this by 12 results in a small unit of 1·04354″.

The inter-relation of these three "inches" becomes apparent when we consider the plot referred to above of $22' \times 22'$ (=1/90 acre).

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Now 22′ equals :

(*i*) 264 British standard inches, or,
(*ii*) $256 \times 1{\cdot}03125''$, or,
(*iii*) $253 \times 1{\cdot}04354''$.

Since $253 = 11 \times 23$, this also introduces into the scale the factor 11. In fact, we may regard (*ii*) as the oldest system of division, since $256 = 2^8$; whilst (*i*) and (*iii*) were possibly alternative methods, in different countries, of introducing the factor 11.

It may reasonably be objected that the similarity between the British and old Maltese units which results in 96 canne = 1 furlong, is suspiciously accurate. It is, indeed, quite possible that the original palmo has been arbitrarily shortened very slightly in recent times, in order to provide this accurate consonance.

If the standard rods were made, as is probable, of bronze, consisting of nine parts of copper to one part of tin, which is known to have been the alloy used in Crete, the coefficient of linear expansion of this alloy is very approximately ·00001 per degree Fahrenheit, so that expansion from 1·03125 to 1·0315 would result from an increase of about 24°F., which approximately represents the difference between summer sun temperatures in Malta and at Greenwich.

It may be of interest to note three consecutive lengths measured by the writer along the axis of a megalithic monument in Malta; the measurements were between most distinctive points, viz: from step to step; the conditions were such that the measurements were not closer than 0·25″ in any one case. The measurements noted were :

(*a*) 5′ 1·75″
(*b*) 13′ 9″
(*c*) 25′ 0·5″

It was only subsequently observed that :

(*a*) 6 palmi = 5′ 1·875″
(*b*) 16 palmi = 13′ 9″
(*c*) $24 \times 12{\cdot}5225'' = 25'\ 0{\cdot}5''$

This affords some evidence that both palmi and " long feet " were used as units of length by the original (Eurafrican) builders in Malta.

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Brigadier-General G. P. Campbell, C.I.E., C.B.E.

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MEMOIR.

BRIGADIER-GENERAL G. P. CAMPBELL, C.I.E., C.B.E.

GEORGE POLDING CAMPBELL was born at Wanstead, New South Wales, in 1864, the second son of Edward Campbell, of Grambalang, who had settled in that country some years previously. Educated at Sydney Grammar School and Sydney University, he carried all before him in the mathematical schools, and was accordingly selected by the then Governor, Lord Carrington, for a commission in the Corps. It was offered to Sydney University as a compliment to the colony of New South Wales for the assistance voluntarily offered by its people in the Egyptian troubles of the time.

Having thus obtained a direct commission, Campbell escaped the "Shop," and joined at Chatham in May, 1886. He stayed there the usual two years and was then appointed to Aldershot. There he became engaged to Frances Georgina, daughter of the Rev. C. B. Fendall, of Woodcote House, Windlesham, one whose unfailing courage and cheerful serenity were to be a great source of strength to her husband in the arduous years to come. Matrimony amongst subalterns was not favourably regarded in those days, and he was promptly ordered to Ceylon. His marriage had consequently to be postponed till his first leave, and took place in 1891, after which the young couple returned to Colombo, where they remained for four years.

Transferred to India in 1894, the Campbells went first to Ferozepore, where he designed and carried out the defences to the arsenal, and then to Bannu. For the whole of his service in India, Campbell was employed on Military Works, and in accordance with the then custom, as a P.W.D. officer when on the N.W. frontier. He was promoted to Captain in 1896, and in the following year took part in the Tochi expedition, the outcome of the widespread frontier agitation then prevailing. At that time, he was the father of four children.

An officer who worked under him writes: "I remember G. P. Campbell best in 1897, when I served under him as Assistant Engineer in the Punjab P.W.D., as it was in those days, in the Tochi Valley. He was my Executive Engineer at Bannu, and I reported to him, I think, in March, and we rode up the valley together to Datta Khel, which was to be my headquarters for the building of the posts at Miramshah, Boya, and Datta Khel, and the road to connect them. He was a cheery, bright soul, well known on the frontier for his yarns

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and after-Mess stories, one of which, 'The Yellow Light,' gave him his nickname at that time. He was a most engaging chief to be under, and a sound practical frontier engineer from whom I learnt many tips.

"The Maizar outrage in June, 1897, put back our building programme before we had done more than put up the political officers' houses and P.W.D. rest houses, and we then concentrated on cutting out some sort of road up which the Tochi Expedition could advance. He and I designed a crib pier bridge over the Tochi at Boya, which carried the troops over dry-shod, but did not long withstand the summer floods; he used to be frequently up and down over my section of the road, which was from Miramshah to Datta Khel, always cheerful and encouraging. I went down with Tochi fever, and was invalided home in November, and the last I remember of his kindness was when he took me into his bungalow at Bannu and nursed me fit enough to stand the tonga journey on. I looked on him as one of the best to serve under, whose one aim was to get things done by personal interest in the work and never a thought of personal risk or exposure. Red tape was an abomination to him, and he never called on an Assistant Engineer for a report if he could possibly come and see for himself. The result was that we all loved him, and did all we could to carry out his suggestions."

And another officer writes: "I first made Campbell's acquaintance at Bannu in the autumn of 1897. Bannu was then the base of operations for the Tochi Valley Expedition. Dysentery was very prevalent and Campbell was one of the many officers who was invalided home towards the end of it. I remember his arriving at Bannu on his way home. The first thing he did was to interview the Staff Surgeon and to get taken off the sick list. He went to the Mess that evening, and returned home about 2 a.m., which was not a bad effort for a man just recovering from a serious complaint. . . . I do not think I met him again until after the War, in 1920, when he was Brigadier-General and Chief Engineer in Waziristan. He was as cheery and genial as ever, and bursting with amusing stories and reminiscences. . . . There is no doubt that, in spite of his extraordinary light-heartedness, he was a very capable officer and a sound engineer. . ."

The Tochi was certainly no health resort in those days. During the expedition, the force suffered no great loss from the enemy, but terribly from the climate, as the memorials at the little church in Bannu, and the cemeteries at Datta Khel and Miramshah testify.

On Campbell's return to India, there followed ten years of ordinary duty as Garrison Engineer in various stations. Promoted Major in 1904, he served from 1905 to 1908 at Barrackpore, where he built the rifle factory. In April of the latter year he went home for a "wild east" course at the S.M.E., which, with his two years at Aldershot, were the only home service he had. The next twelve

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years were passed almost entirely on the N.W. frontier, mainly at Peshawar, where he carried out civil works as a P.W.D. officer, as well as performing the normal duties of an officer of the Military Works Department. During this time, much important work fell to his lot, and he carried it out in a manner which showed that he possessed the qualities of a really fine engineer of taste and ability. The stately buildings of Islamia College and the beautiful official residence of the Chief Commissioner stand as examples of an architectural understanding of no common order, whilst a lasting memorial to him exists in the double roads up the Khyber, which were aligned and constructed under his direction.

Campbell was promoted to Lieut.-Colonel in 1913; the outbreak of the Great War found him still at Peshawar, whence he took part in the operations against the Mohmands and Swatis in 1915. For his services on this occasion he received the brevet rank of Colonel.

In 1916, he was transferred to Quetta, where he was called upon to carry out much important work in connection with the camps for the additional troops who were stationed there during the war. For his work at Quetta he was made a companion of the Order of the British Empire.

An officer under whom he served then and earlier in his service, writes: "G. P. Campbell served under me at two different periods—once from 1895–97 on the Punjab Frontier at Bannu, and again about 1916–18 at Quetta. On both occasions I found him an excellent man to work with—always cheery and full of life, even in the hottest weather, when most men are liable to be depressed. He was well read, had a good memory, fond of a joke even when it was at his own expense, and the best of company—no dinner party of which he was a member suffered from flagging of conversation, and possibly these powers of conversation may not always have been of advantage to him. I remember he told me once shortly after he joined me on the frontier that he had been badly reported on by his C.R.E., and when he expostulated 'But, Colonel, I have only served under you for a short time and you have not, I think, seen any of my work,' he received the reply, 'No, I have not seen your work, but I met you out at dinner once, and you talked too much.' I found him officially a very capable, zealous and efficient officer, who took a keen interest in his work and was ever ready to help; personally a very kind-hearted, hospitable and reliable friend whose loss I deeply deplore."

The following extract from a letter from an officer of the I.M.S., a very old friend of the family, gives a good idea of Campbell's unselfish character: "My first meeting with Campbell was when he discovered me all alone and very ill indeed in the old club at Sheikh Budin. I had just arrived in India and the Derajat for the first time and in May. He carried me off to the bungalow of a friend and sat up several nights looking after me. He must have had an anxious

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time of it, as I was the only doctor in the place, but he took my temperature, sponged me down, filled me up with quinine, and wired to D.I.K. for instructions to carry on. And when I got better, he spared no pains to see that I was put up to all the ropes as to how to live in an Indian climate.

"Unselfishness was so ingrained in Campbell's nature that the interest and trouble he took in everyone around him never seemed any effort to him. . . .

"The backbone of Campbell's character was a great faith in life and an unswerving loyalty to high principles. With all the worries of executive work under trying conditions, and with all the anxieties of a large family in an Indian climate, he was always cheery, and his kindly sympathy, which made him so full of thought for others, also enabled him to see humour in everything going on around him.

"His wife was a splendid help to him, and always cheerful in all vicissitudes, and that is saying something, for with his boyishly humorous temperament no one ever knew what Campbell would do next."

In 1919, Campbell was appointed Chief Engineer of the Waziristan Field Force, and went at first to Bannu. He was much interested in the development of the Tochi Valley, in which he had done pioneer work over twenty years before, especially in the motor road up the valley to Miramshah, which for most of its course followed the alignment of his tonga road of '97.

Later in the year, his headquarters were moved to Dera Ismail Khan, and there a small group of Sappers, with the C.E. at its head, spent a pleasant winter together in the A.C.R.E.'s bungalow, brightened by the presence of Mrs. Campbell and her youngest daughter. As C.E. he was responsible for the alignment of the part of the Waziristan circular road (which included the passage of the ill-omened Hinnis Tangi) from Khirgi up the Zam Valley towards Razmak, a work of primary importance in the settlement of that troublous country. For his services in Waziristan he was made a Companion of the Indian Empire.

Long residence in India had undoubtedly told upon his health, and in 1920 he was invalided home and retired as Brigadier-General in August, 1921, with over 35 years' service to his credit. After a few months, he finally settled in Farnham, where he was in touch with old friends, and continued his life of useful service by acting as Chairman of the Aldershot, Farnham and District War Pensions Committee—a position which he resigned only a short time before his death—and as local Secretary of the Soldiers' and Sailors' Association.

He died of pneumonia on September 9th, 1928, after a long illness borne with quiet courage, and is survived by his widow and eight children, of whom his four sons are in the Army.

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Campbell was a man of great mental and physical energy. At Aldershot he hunted a good deal. He played golf all his life, and represented the Corps at Sandwich in 1898. He also played polo and cricket, and did some big game shooting in Ceylon. Apart from games of all kinds, his chief recreation was writing. He was well read and had an easy style, and was never at a loss for a word. For several years he contributed to papers in India, acting as a correspondent to the *Statesman*, *Pioneer*, *Civil and Military*, and other publications, as well as contributing articles, reviews and poems.

Perhaps his most salient characteristic was his religious sincerity. He was a devout Catholic, and his devotion was of no theoretical kind, but showed itself in the breadth and kindness of his nature and the conscientious and thorough fulfilment of all his duties. He had a strong sense of humour, which often led him to view things, including official business, from an unaccustomed angle, and perhaps endeared him more to those amongst whom he lived than to those under whom he served. For though entirely loyal and single-minded in his desire to accomplish whatever his task might be, he was utterly intolerant of the petty obstructions which often arise from the unintelligent application of prescribed methods.

To one who knew him well during his time as Chief Engineer in Waziristan, he leaves a memory of unfailing cheerfulness, most pleasant companionship, great personal attraction, and unswerving devotion to his lofty ideals.

A.H.B.

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BATTLE HONOURS OF ROYAL ENGINEER UNITS.

(Continued from December, 1928, R.E. Journal.)

SIGNALS.

MEGIDDO. I.—SHARON. 19TH TO 25TH SEPTEMBER, 1918.
II.—NABLUS. " " " " "

Unit.	Formation.		Remarks.
	I.—SHARON.		
U Corps Signal Co.	XXI Corps	E.	
54th Div. Signal Co.	54th Div.	"	
75th "	75th "	"	
3rd Indian "	3rd Ind. Div.	"	
7th Indian "	7th "	"	
60th "	60th Div.	"	
W Corps Signal Co.	Desert Mtd. Cps.	"	
4th Cav. Div. Sig. Sqdrn.	4th Cav. Div.	"	
5th "	5th "	"	
2nd Aust. Signal Sec.	Aust. Mtd. Div.	"	
	II.—NABLUS.		
V Corps Signals Co.	XX Corps	"	
10th Div. Signal Co.	10th Div.	"	
53rd "	53rd "	"	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	"	

DAMASCUS. 1ST OCTOBER, 1918.

Unit.	Formation.		Remarks.
XXI CORPS.			
No. 3 Co. 1st K.G.O. S. and M.	7th (Indian) Div.	E.	
No. 4 "	"	"	
522nd (London) Field Co.	"	"	
14th Army Troops Co.	XXI Corps	"	
DESERT MOUNTED CORPS.			
4th Field Sqdrn.	4th Cav. Div.	E.	
5th "	5th "	"	
2nd Aust. Field Sqdrn.	Aust. Mtd. Div.	"	

SIGNALS.

DAMASCUS. 1ST OCTOBER, 1918.

Unit.	Formation.		Remarks.
W Corps Signal Co.	Desert Mtd. Cps.	E.	
4th Cav. Div. Signal Sqdrn.	4th Cav. Div.	"	
5th "	5th "	"	
2nd Aust. Signal Sqdrn.	Aust. Mtd. Div.	"	
U Corps Signal Co.	XXI Corps	D.	
7th (Indian) Div. Sig. Co.	7th Indian Div.	E.	

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MESOPOTAMIA.

Unit.	Formation.		Remarks.
BASRA. 15TH TO 17TH NOVEMBER, 1914.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
SHAIBA. 12TH TO 14TH APRIL, 1915.			
17th Co. S. and M.	6th (Indian) Div.	,,	
22nd ,,	,,	,,	
12th ,,	12th (Ind.) Div.	N.E.	
Sirmur Imp. Service Co.	,,	,,	
Bridging Train		,,	
KUT, 1915. 28TH SEPTEMBER, 1915.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
12th Co. S. and M.	12th (Ind.) Div.	N.E.	
Sirmur Imp. Service Co.	,,	,,	
CTESIPHON. 22ND TO 24TH NOVEMBER, 1915.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
DEFENCE OF KUT. 7TH DECEMBER, 1915, TO 28TH APRIL, 1916.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
Sirmur Imp. Service Co.	12th (Ind.) Div.	,,	

SIGNALS.

Unit.	Formation.		Remarks.
BASRA. 15TH TO 17TH NOVEMBER, 1914.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
SHAIBA. 12TH TO 14TH APRIL, 1915.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	N.E.	
KUT, 1915. 28TH SEPTEMBER, 1915.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	N.E.	
CTESIPHON. 22ND TO 24TH NOVEMBER, 1915.			
A.C. Signal Co.	II Ind. Army Corps	D.	1 Section only in area.
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	D.	1 Section only in area.
Bde. Signal Troop	6th Cav. Bde.	E.	
DEFENCE OF KUT. 7TH DECEMBER, 1915, TO 28TH APRIL, 1916.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	D.	1 Section only in area.
TIGRIS, 1916. 6TH JANUARY TO 22ND APRIL, 1916.			
No. 1 A.C. Signal Co.	Tigris Corps	E.	
3rd Div. Signal Co.	3rd (Indian) Div.	,,	
7th ,,	7th ,,	,,	
13th ,,	13th ,,	,,	

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TIGRIS, 1916.
6TH JANUARY TO 22ND APRIL, 1916.

Unit.	Formation.		Remarks.
TIGRIS CORPS.			
20th Co. S. and M.	3rd Div.	E.	
21st ,,	,,	,,	
3rd ,,	7th Div.	,,	
4th ,,	,,	N.E.	
72nd ,,	13th Div.	E.	
88th ,,	,,	,,	
CORPS TROOPS.			
12th Co. S. and M.	Attached 3rd Div.	,,	
13th ,,	Attached 7th Div.	,,	
Bridging Train	1st S. and M.	,,	
Field Troop	2nd S. and M.	N.E.	

KUT, 1917.
9TH JANUARY TO 24TH FEBRUARY, 1917.

Unit.	Formation.		Remarks.
CAVALRY DIVISION.			
No. 2 Fd. Trp. 2nd S. & M.	6th Cav. Bde.	E.	
7th Field Troop R.E.	7th ,,	,,	
I INDIAN ARMY CORPS.			
No. 18 Co. 3rd S. and M.	3rd Ind. Div.	,,	
No. 20 ,,	,,	,,	
No. 21 ,,	,,	,,	
No. 1 Co. 1st S. and M.	7th Ind. Div.	,,	
No. 3 ,,	,,	,,	
No. 4 ,,	,,	,,	
III INDIAN ARMY CORPS.			
71st Field Co.	13th (West.) Div.	,,	
72nd ,,	,,	,,	
88th ,,	,,	,,	
No. 12 Co. 2nd S. and M.	14th Ind. Div.	,,	
No. 13 ,,	,,	,,	
No. 15 ,,	,,	,,	
ARMY TROOPS.			
No. 1 Bridging Train		,,	
No. 2 ,,	1st S. and M.	,,	
No. 3 ,,	3rd ,,	,,	
Searchlight Co.		D.	No diary.
Tehri Garhwal S. and M. (I.S.)		E.	

SIGNALS.
KUT, 1917. 9TH JANUARY TO 24TH FEBRUARY, 1917.

Unit.	Formation.		Remarks.
Army Signal Co.	Tigris Front	E.	
1st (Anzac) Wireless Sig. Sqdrn.	Cavalry Div.	,,	
6th Cav. Bde. Sig. Troop	,,	,,	
7th ,,	,,	,,	
1st Corps Signal Co.	I Ind. Army Cps.	,,	
3rd Div. Sig. Co.	3rd Ind. Div.	,,	
7th ,,	7th ,,	,,	
3rd Corps Sig. Co.	III Ind. Army Corps	,,	
13th Div. Sig. Co.	13th (West.) Div.	,,	
14th ,,	14th Ind. Div.	,,	

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BAGHDAD, 1917.

25TH FEBRUARY TO 10TH MARCH, 1917.

Unit.	Formation.		Remarks.
CAVALRY DIVISION.			
No. 2 Fd. Trp. 2nd S. & M.	6th Cav. Bde.	E.	
7th Field Troop R.E.	7th ,,	,,	
I INDIAN ARMY CORPS.			
No. 18 Co. 3rd S. and M.	3rd Ind. Div.	,,	
No. 20 ,,	,,	,,	
No. 21 ,,	,,	,,	
No. 1 Co. 1st S. and M.	7th Ind. Div.	,,	
No. 3 ,,	,,	,,	
No. 4 ,,	,,	,,	
III INDIAN ARMY CORPS.			
71st Field Co.	13th (West.) Div.	,,	
72nd ,,	,,	,,	
88th ,,	,,	,,	
No. 12 Co. 2nd S. and M.	14th Ind. Div.	,,	
No. 13 ,,	,,	,,	
No. 15 ,,	,,	,,	
ARMY TROOPS.			
Tehri Garhwal S. & M. (I.S.)		N.E.	
No. 1 Bridging Train		E.	
No. 2 ,,		,,	
No. 3 ,,		N.E.	

SIGNALS.

BAGHDAD. 25TH FEBRUARY TO 10TH MARCH, 1917.

Unit.	Formation.		Remarks.
Army Signal Co.	Tigris Front	E.	
No. 2 Wireless Sig. Sqdrn.	L. of C.	N.E.	
Cav. Div. Signal Sqdrn.	Cav. Div.	D.	No diary.
1st (Anzac) Wireless Sig. Sqdrn.	,,	E.	
6th Cav. Bde. Sig. Troop	,,	,,	
7th ,,	,,	,,	No diary.
1st Corps Signal Co.	I Ind. Corps	,,	
3rd Div. Sig. Co.	3rd Ind. Div.	,,	
7th ,,	7th ,,	,,	
3rd Corps Sig. Co.	III Ind. Corps	,,	
13th Div. Sig. Co.	13th (West.) Div.	,,	
14th ,,	14th Ind. Div.	,,	

KHAN BAGHDADI, 1918.

26TH TO 27TH MARCH, 1918.

Unit.	Formation.		Remarks.
No. 5 Fd. Trp. 1st S. & M.	11th Cav. Bde.	E.	
448th Field Co.	15th Ind. Div.	,,	No diary.
450th ,,	,,	,,	
451st ,,	,,	,,	
No. 19 Fd. Co. 3rd S. & M.	I Ind. Army Cps.	N.E.	Attached 15th Div.
No. 1 Bridging Train, 1st S. and M.	,,	E.	
No. 2 Bridging Train, 1st S. and M.	,,	,,	

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SHARQAT, 1918.

28TH TO 30TH OCTOBER, 1918.

Unit.	Formation.	Remarks.
No. 5 Fd. Trp. 1st S. & M.	11th Cav. Bde.	E.
No. 7 ,,	7th ,,	,,
448th Field Co.	15th Ind. Div.	N.E.
450th ,,	,,	,,
451st ,,	,,	,,
Sirmur Sappers (I.S.)	17th Ind. Div.	,,
Malerkotla Sappers (I.S.)	,,	E.
Tehri Garhwal Sappers (I.S.)	,,	,,
No. 2 Fd. Co. 1st S. & M.	18th Ind. Div.	,,
No. 5 ,,	,,	N.E.
No. 6 ,,	,,	E.
No. 8 ,,	,,	,,
9th Co. 2nd S. and M.	Attd. 15th Div.	N.E.
19th Co. 3rd S. and M.	,,	,,
No. 1 Bridging Train		,,
No. 2 ,,		E.
No. 3 ,,		N.E.

SIGNALS.

Unit.	Formation.	Remarks.
KHAN BAGHDADI. 26TH TO 27TH MARCH, 1918.		
Bde. Signal Troop	11th Cav. Bde.	E.
15th Div. Sig. Co.	15th Ind. Div.	,,
SHARQAT, 28TH TO 30TH OCTOBER, 1918.		
1st Corps Signal Co.	I Ind. Army Cps.	E.
Bde. Signal Troops	7th Cav. Bde.	,,
,,	11th ,,	,,
15th Div. Signal Co.	15th Ind. Div.	N.E.
17th ,,	17th ,,	E.
18th ,,	18th ,,	,,

[EDITOR'S NOTE.—*This completes the list of Battle Honours of Royal Engineer Units. Previous instalments appeared in the R.E. Journals for June, September and December, 1925; March, June, September and December, 1926; March, June, September and December, 1927; September and December, 1928*].

N. = Eligible.
N.E. = Not Eligible.
D. = Doubtful.

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PROFESSIONAL NOTES.

REPORT OF THE BRIDGE STRESS COMMITTEE.

(H.M. Stationery Office, 1928. 18s. net).

THE Bridge Stress Committee was appointed in 1923 by the Privy Council Committee of Scientific and Industrial Research to enquire into the nature of stresses caused by moving trains over steel railway girders.

The Bridge Committee included Sir Alfred Ewing and Professor Inglis, and consisted of four scientists and six railway engineers, and they employed a chief engineer and some fourteen engineers for five years making experiments.

CONDEMNATION OF EXISTING PRACTICE.

The report opens on page 8, with a condemnation of impact formulæ hitherto made use of which are described in detail in Appendix "A." The Committee in these paragraphs seem to have demolished a bogey of their own making.

It has been common knowledge for forty years that impact is due to many causes, and that the effect varies with the type of girder. As Mr. Stone wrote on a Government of India file in 1892, "the coefficient, if accurately determined, would not only differ for each member of a bridge, but it would probably differ to some extent with changes of temperature, and it would certainly again differ for different designs of engine and different speeds of train. Hence it is generally admitted that to apportion consistently the working stress to every case which may occur, is quite out of the question. There must be a compromise."

For this reason it has been recognized that to attempt to devise a formula or law for impact analytically is to search for a chimera. This committee have not held that view, and it remains to judge whether they have succeeded in justifying their optimism.

With regard to so-called formulæ now in use, no one has ever suggested that they were a sort of mathematical impact law. In fact, they are no more than a convenient way of expressing what extra allowance must be made for impact for any given span, and as such they differ in no way from the table of equivalent loads which this committee has published on page 133 in its report.

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The only value of these expressions is to give the impact allowance in convenient form. Whether it is worth while retaining this kind of formula is another question, but there is no need for the blows which the committee have showered on them, nor indeed any justification.

The original impact formula was :—

$$Y = 2.$$

But no one supposed it to be a law of impact.

The Pencoyd formula improves on this :

$$Y = 1 \text{ plus } 300/300 \text{ plus } L$$

and both these formulæ were generally considered of universal application, whatever other factors of safety were used.

The Indian formula Y = 1 plus 65/45 plus L improves on the Pencoyd in many ways by being restricted

(1) To 5'6" gauge railways.

(2) To modern design girders.

(3) To locomotives with hammer blow restricted by the equation

$$\frac{\text{hammer blow at 1 r.p.s.}}{\text{total load per foot run for which bridge is designed}} = 1/5.$$

(4) To normal working speed. This is implicit in the ratio in item 3.

(5) For working stresses of eight tons per sq. inch of steel.

Mr. Fyson's formula is not one which is generally known, but to print it as is done on the diagram (page 144) is to confuse the reader unnecessarily.

Bridges designed with this impact allowance, and 14,000 lbs. per square inch working stress, for which it was intended, will be almost identical with bridges designed with the new Indian formula for which a working stress of 18,000 lbs. is used.

The Committee go on to say, " There is no proportionality between the impact effect of a live load on a given bridge and the amount of the load ; consequently the idea of an impact coefficient is fundamentally wrong."

I disagree entirely with this sweeping statement. The Committee seem to overlook the fact that bridges are designed for a given load, and that there is a definite proportion between the weight of a bridge, the load for which it is designed, and the effect of the load, always assuming that engines and bridges are normal and not unusual designs.

What the Committee perhaps have in mind is that these formulæ are not capable of solving the problem of the impact effect of any load on any girder. But such a formula is unattainable, and the search for it is as futile as the search for the Philosopher's Stone. Moreover,

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it is of no importance in bridge design to know what impact effect may be given by any load except the load for which the bridge is designed.

This leads me to examine what seems to be the

Committee's Fundamental Error.

The Committee appear to have fallen into the error which our Indian Committee avoided, of observing high impact effect on under-loaded bridges, and applying the results to fully loaded bridges.

The methods by which the loading recommended has been reached may be found in Figs. 71–75 and para. 167–171.

From this it appears that the maximum loading which has been arrived at by computation is the result of inserting in the calculations for the weight M of the girder various estimated values, ranging from what they describe as light weight, to heavy weight bridges.

There is no such thing as a light weight or a heavy weight bridge; there is only one economic weight for a railway bridge for a given loading, and the effect of that loading on bridges of other weights designed for other loadings is of no interest.

The whole point of impact investigations is to enable the economic weight to be more accurately determined. The diagrams of mass shown in Fig. 71, show a misconception of the problem before the Committee. The diagram shows three bridges experimented upon in the neighbourhood of 150 ft. span, with weights ranging from 600 tons down to 200 tons. The 600-ton bridge is a four-track structure. All were tested with single engine 15/15 test trains. In the region of 310 ft. two bridges are shown, one of 1,700 tons weight and the other of 1,100 tons weight, and to bring these two bridges together on one diagram is of no practical value. They are two different problems quite independent.

In the diagram in Fig. 72 (2), which is based on computation, it is shown that the impact allowance for light bridge, 150 ft. span, for 15/15 loading, single track, is about 63%, but for a heavy bridge it is 121 %, and adding various allowances for joints and lurching, the Committee recommend an impact allowance of 147 % for all 150 ft. spans on British railways. It is clear that if the light bridge is a correct weight for this loading and 63 % is sufficient for impact, then there is no need to consider what impact effect it has on a heavy bridge, because the heavy bridge is designed for much heavier loads; that is the only reason for its heaviness.

The absurdity of the diagram Fig. 72 (2) is shown by the position of the curves between 160 ft. and 200 ft. span, from which it might be deduced that the more impact allowance is given the lighter becomes the bridge. The same result is shown in diagram 3, span 130 ft. to 170 ft.

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It is evident that the excessive impact allowance which the Committee recommend for medium span bridges is based on some fundamental error of observation or conception of the problem, and multiplied in the course of computation beyond the error to which experiment alone would have led.

It is possible that 147 % impact might be obtained experimentally on 150-ft. girders, supposing that two coupled engines could be got to move at 90 miles per hour, on bridges less than a quarter loaded and using engines with an exceptionally large hammer blow, but in any case I feel sure that such impact allowance is unnecessary for fully loaded bridges.

The frequency diagram in Fig. 71 is also rather unnecessary. Weight being governed by loading, frequency varies with depth of girder, and depth is usually governed by considerations of design, such as head room and a need for a certain rigidity to reduce deformation stresses.

OTHER REMARKS ON FIGS. 71 AND 75.

The diagrams in Figs. 71 and 72, even if misleading in other ways, are interesting as showing it is desirable to keep the depths of girders as low as possible in spans from 100 ft. to 200 ft. But, practically, it is not possible to build low girders for these spans, because the overhead bracing interferes, except in England, where headway is very low. English railways would be wise to build their bridges for the future, and provide increased head room. In any case, depth should be sufficient to keep down deformation stresses.

The diagrams and list of bridges are also interesting, as they show that most of the girders are shallow and do not conform to modern practice in other countries. For this reason, it must be supposed that the Committee would recommend for modern design of girders even higher impact allowance than 147 %.

It is generally agreed that half this is more than sufficient, and the verdict of history proves that it is sufficient, for no girders designed by the Pencoyd method have been known to fail from impact. This being so, it seems certain that there are fundamental errors in the assumptions and coefficients on which the computations and recommendations of the Committee are based.

THE EFFECT OF IMPACT ON SHEAR.

The Committee's treatment of shear is very valuable. The effect of impact on shear load is very clearly explained in para. 107 *et seq.* The conclusion is that the allowance for impact in web members may be less than on the booms. This bears out the opinion I gave the Indian Committee, but which the Committee did not find evidence to support. Whether the Indian formula should be modified by

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calling L the span instead of the loaded length is worth considering. Practical designers are rather in favour of keeping web members stronger than strict computation shows, for various reasons.

The diagram, Fig. 77, shows that the Committee consider the allowance for impact in web members of 150-ft. span, single track bridge, 15/15 loading, may be 18 % at the centre, 23 % at the ¾ point, and 32 % at the ends.

What the Committee have Accomplished.

The causes of impact have long been known, and there is no need to repeat them here. The Committee do not develop any new theory on the subject.

They have, however, experimentally verified by special apparatus that Professor Inglis' analytical investigations approximate to the effect of moving trains on bridges, provided that a correct appreciation is made of the coefficients and assumptions.

It was Professor Inglis' mathematical analysis which was published five years ago which enabled the Indian Committee to arrive at their conclusions.

The Committee have also proved experimentally that the amplitude of oscillation of the bridge is proportional to the hammer blow, if the engine is stationary in the centre of the bridge, and they assume the law applies to moving engines.

They also show experimentally that the greatest vibrations of the bridge occur when the frequency of the vibrations coincides with the frequency of the hammer blow, and that increasing the speed does not increase the amplitude of vibrations.

A valuable section of the Committee's work deals with shear as I have explained.

The Committee's Recommendations.

But it is with the practical results of the Committee's work that most engineers are concerned, and to understand them it is necessary to realize that English railways differ considerably from those of any other country in the world.

Owing to the smallness of the loading gauge it has not been possible to build large engines, and this has prevented the increase of goods train loads. The result is that, on English railways, it is the heavy passenger locomotive of high speed which controls bridge design, rather than a heavy goods engine. Moreover, the cramped space in which the working parts of the locomotive have to be fitted has forced engineers to design peculiar types of engine, and they have been forced to conclude that the largest type of locomotive ever likely to be put on English railway tracks will never exceed eight wheels coupled with 20 tons axle load. Even this can only be achieved with

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four cylinders. The British Engineering Standard locomotive is a type which is suited to British railways only, and contemplates the use of four-wheeled coupled engines with axle loads 25 % higher than the goods engine. No railway outside England would be likely to use such a standard.

COMMITTEE RECOMMENDATIONS FOR ENGLISH RAILWAYS.

These considerations have led the Committee to decide that the heaviest locomotive is not likely to develop much hammer blow, the main cause of impact. They have in this way evaded their difficulty to a large extent by removing the cause of impact.

But while other engineers have realized that the hammer blow should be reduced as much as possible, it has hitherto been supposed that the expense of making four-cylinder engines, and the expense of running them, was not justified merely to get rid of impact. These engineers are, therefore, interested mainly in knowing what impact allowance the Committee gives for locomotives which unfortunately still develop a moderate hammer blow.

For these the Committee's report gives not much guidance. They specify the impact allowance for a few spans for certain engines with 15-ton axle loads, and with a rather high hammer blow. It is possible that high hammer blow is an unavoidable characteristic of English locomotives.

The Committee give tables and diagrams of uniform equivalent loads for various speeds, and they assert that with speeds of six revs. per second high impact effects are caused. Six revs. a second means that goods trains are running at 60 m.p.h. I did not know it was possible to run an eight-wheel coupled goods at this speed; it must be like running a Ford at 60 m.p.h., but the Committee did manage to run them at this speed.

Practically, 60 m.p.h. is not a normal working speed for goods trains, and it is not necessary to build bridges to that standard.

Similarly, six r.p.s. means running passenger engines at 90 m.p.h. Here again this is not normal working speed, and there is no need to provide for these speeds.

One could not imagine two such engines coupled running at 90 m.p.h., but that is the load which the Committee adopt for single line bridges. Still less could one imagine eight of this particular type of engine all passing the centre of a four-track bridge simultaneously at 90 m.p.h., and four of them in phase.

In a footnote to page 113 it is admitted that these speeds are abnormal, and have no application to fully loaded bridges, but if so, it is not clear why the Committee publish tables of loading for these speeds.

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Application to Other Railways.

For a speed of 4½ r.p.s., which is ample for all practical bridge design, the Committee's recommendations give results which may be compared in a few cases with practice hitherto adopted. The loadings to be allowed are arrived at by calculation, and the method of calculation is shown in Appendix J.

In order to apply the report to the requirements of railways of other gauges and other conditions of loading, these calculations would have to be followed for each case. Whether the percentage would work out the same for other railways, it is not possible to say, but the total allowance for British railways for locomotives of about 15-ton axle load, and 15-ton hammer blow, including lurching, may be compared with the general formulæ hitherto adopted.

The impact allowed for single track bridges, and two 15-ton unit locomotive with 15-ton hammer blow at 4·5 r.p.s., works out from the diagram 63 as follows :—

10 ft. span	..	.. 70 %
20 ft. span	..	.. 50 %
30 ft. span	..	.. 50 %

and from the loadings on page 133, including lurching allowance for 15-unit locomotive

$$40 \text{ ft. span } \frac{164 + 17}{97} = \frac{181}{97} = 86\ \%$$

$$60 \text{ ft. span } \frac{228 + 23}{128} = \frac{251}{128} = 96\ \%$$

$$100 \text{ ft. span } \frac{323 + 35}{194} = \frac{358}{194} = 84\ \%$$

For longer spans the diagrams do not indicate impact load separately, but at 6 r.p.s. the diagram on Fig. 75 shows that 15-unit loading requires the following impact allowance.

$$150 \text{ ft. span } \frac{630 + 71}{284} = 147\ \%$$

I do not think anyone will accept these loadings. No one would care to allow only 50 % on 20 ft. spans, certainly not in India; it is not worth while.

90 % impact for 60 foot span is higher than the old Pencoyd formula, which is universally accepted to be far too high. The 147 % impact is quite unreasonable.

In view of the fact that these results fit in with no known experience, I cannot think that any engineer will trouble to go through the laborious calculations recommended in this report rather than trust to empirical allowances based on observation.

No doubt by shuffling the coefficients it would be possible to obtain

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results to fit in with practice, but it would be difficult to have confidence in the answers. The calculations are most laborious, but the Committee consider that the Appendix J will enable bridge engineers to apply the theory put forward.

The assumptions and coefficients on which the calculations are based are numerous. Two engines are supposed to be stationary in the centre of the span with their driving wheels revolving free and in phase; the locomotives are idealized and the chassis weight and body weight are taken separately; coefficients for the frequency of the bridge, of the hammer blow, the engine body, and the damping effect of springs are required. This is for single-line bridge, and the calculations extend to three printed pages and include some graphic analysis.

For double tracks the assumptions are more complicated.

A very gallant attempt has been made to work out mathematically the allowance for impact, but the result tends to confirm what Mr. Stone said in 1892 about the nature of the compromise necessary to solve the problem of impact.

The investigation and explanation of all the detailed phenomena of impact have never before been more carefully examined, and I imagine the last word has been said on the subject from the point of view of the analytical investigator, but I think that, in future, bridge engineers will be content to design girders with the empirical allowance for impact based on experiments which cover all the different causes of impact, including chance, luck, personal error, and the state of the weather in one simple observation.

Whether bridge engineers, even of English railways, will accept the loadings recommended would seem to be doubtful. Rather than allow 147 % impact, it would be better to put a speed restriction on the engines with excessive hammer blow.

For those who have to prepare rules for the design and inspection of girder bridges, the report will provide much valuable guidance, but practical needs call for more simple methods of finding impact allowances than the laborious analytical method.

I may draw attention to the Committee's remarks on the question of relief of stress from floors and so forth. They decline to make any recommendation. They, like the Indian Committee, leave it to designers to allow for such relief, if it seems to be justified in any particular case.

In the result the Committee have advanced our knowledge of the effect of impact on shear members, and have generally carried the theory of impact further than it has hitherto been found possible, but their practical recommendations are likely to be viewed with some scepticism by those who design girder bridges for railways.

L. E. HOPKINS, *Lieut.-Colonel.*

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"COLAS" ROADS.

A SECOND edition of this book has just been published by Colas Products Ltd., 38, Parliament Street, Westminster. A short note on the original edition appeared in the *R.E. Journal* of June, 1927.

The new book has been somewhat enlarged and brought up to date, as a result of more recent experience. It gives a very good account of the advantages of using "Colas," and describes clearly the best methods of using it under varying circumstances.

"Colas" is an emulsion of bitumen and water. The water carries the bitumen down through the interstices of the road metal, and on drying out leaves a film of bitumen, which acts as a grouting material and binder between the various pieces of stone. In this way the top portion of the road surface is consolidated and made waterproof.

The grouting can be carried out either as a "full" grout, in which case the emulsion can be made to penetrate to a depth of three inches below the surface, or as a "semi" grout, where the "Colas" only penetrates the top inch or so. It can also be used as surface dressing.

"Colas" is applied cold, and this is one of its main advantages. It can also be used under almost any weather conditions, other than hard frost. It is said to be equally satisfactory in the tropics as in colder climates.

Owing to the fact that no heating apparatus is required, it is specially suitable in those cases where roads have to be patched. The "Colas" is then applied by using ordinary watering cans, which can be filled on the spot from the metal drums in which the "Colas" is supplied.

For extensive work, the company supply "Colas" in 1,000 gallon tanks, fitted on a lorry chassis and equipped with an air-pressure feed and spraying jets.

The book contains useful specifications for the various types of work which can be carried out with "Colas," viz., full-grouting, semi-grouting, surface dressing, and patching, as well as surface dressing on wood paving, stone sets, or new tar macadam. There are also some useful tables of cost and quantities of materials required for various types of work. It should certainly be read by anyone interested in modern roadwork.

C. C. P.

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BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE OFFICIAL HISTORY OF THE WAR—GALLIPOLI, VOL. I.

By BRIGADIER-GENERAL C. F. ASPINALL-OGLANDER, C.B., C.M.G., D.S.O.

(Heinemann, 1929. Price 19s. 6d.)

In this volume the author presents a well written, clear and readable narrative of the initiation of the Dardanelles campaign and of the operations connected with the landing up to the final failure of the attack to secure Achi Baba.

The narrative of events is fair and candid. Failure where it occurred is frankly admitted, and the reasons for failure are not represented as unavoidable.

The book is, however, written with a measure of reserve inevitable in an official history compiled so soon after a war.

The student will get from the book a good general pictur, ebut he will do well to read the Australian official history for a more vivid description of the almost inevitable confusion which has to be dealt with in an opposed landing. He will also have to consult other publications for a fuller grasp of the administrative problems.

In his preface the author discusses the questions whether, in 1915, an attempt to force the Dardanelles was strategically sound in view of the general situation, and if so whether tactically it was a feasible operation. To the former question he is clearly of the opinion that the answer is "Yes," provided that for the time being the British Army in France remained on the defensive and that the Dardanelles campaign became the main British effort.

To the latter question his answer is a more definite affirmative. Even as undertaken, the operations, he considers, were within an ace of success.

His opinion is that the whole story is one of lost opportunities. That cannot be denied, but the extent of the opportunities presented may be questioned. A greater initial measure of success might have caused the collapse of the morale of the Turkish leaders or of the less reliable Turkish troops. On the other hand, it might only have drawn Sir Ian Hamilton's forces into a more dangerous situation.

The book is in three parts, and with the appendixes gives most of the information essential to the strategical and tactical study of the operations.

Part I gives a very full account of the stages by which we drifted into the campaign, bringing out the lack of centralized control, co-ordination of effort, and a clear-cut plan. The facts must already be familiar to most students, and we have every reason to believe that the reconstituted Committee of Imperial Defence and the better understood duties

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of the General Staff will safeguard us against a repetition of the mistakes made.

General Aspinall-Oglander corrects the view entertained by the Dardanelles Commission that the delay in the dispatch of the 29th Division had serious results. He points out that weather conditions would have prevented its employment at an earlier date. Incidentally, this brings out how little probable weather conditions appear to have been taken into consideration in the initiation of either the naval or military operations, a point which normally should have been one of the first to be taken into account. Actually, the landing was carried out at the most suitable date, which makes the premature naval operations, themselves handicapped by the weather, all the more regrettable.

When one comes to the military plans for the operations, it is a pity that the full text of the appreciation on which the final selection of the points of landing was based is not given in the Appendix.

The summary of the appreciation included in the text leaves the reader in some doubt as to the exact object of the double landing.

The orders and instructions contained in the Appendixes throw considerably more light on this point, especially the instructions to General Birdwood given in Appendix 5. It was evidently not anticipated that the Anzac landing would materially assist the Helles forces in capturing its initial objective, the Achi Baba ridge, but was designed to affect further operations against Kilid Bahr.

The effect of the double landing on the Turkish morale was no doubt great and with a less determined enemy might well have produced decisive results. At the same time, the risk of the Anzac landing receiving the full blast of a counter-attack by Turkish reserves and reinforcements was a danger.

A danger which would have been even greater had the initial success of the Anzac attack carried it nearer to its objectives. General Aspinall-Oglander considers that G.H.Q. underestimated the fighting value of the Turk, especially in power of manœuvre, and gives reasons why this underestimate, which evidently had a dominating influence on both strategical and tactical plans, was formed.

The great disadvantage which in practice the double landing entailed was that: it led to the simultaneous employment of the whole available force, and left little reserve of power in hand. Moreover, it employed the resources of the Navy to the utmost, and at neither landing was there a floating reserve, not committed to a time programme, available to take advantage of unforeseen opportunities. The lack of such reserves becomes very evident in the narrative.

The chapter in Part I dealing with the Turkish preparations and dispositions for defence repays careful study. It brings out clearly the difficulties which must nearly always present themselves in meeting a threat of overseas invasion; the uncertainty as regards the exact point of landing, and the inducement to dispersion consequent on this uncertainty. The advantage the defence has, if it can bring fire on to landing craft, is so obvious that the temptation to strengthen the "crust" at the expense of depth is very great. On the other hand, to make the whole "crust" strong enough to ensure that every possible landing place is guarded, and that the troops holding it have adequate cover

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from concentrated fire of naval guns means great expenditure of personnel and labour. Troops are tied to their positions, and penetration at a single point may bring down the whole edifice of defence. The Turkish dispositions under German advice erred almost to the other extreme, and the forces detailed to the defence of the "crust" were surprisingly weak; to a degree not anticipated by the attack, and not recognized at the time.

The success of the dispositions owed not a little to the wonderful fighting qualities displayed by the Turkish soldier. Had he failed in any way, reserves would have arrived too late, and might well have been beaten in detail as they arrived.

Still, on the whole, the Turkish dispositions may be taken as fairly typical of what a landing force may expect to meet. The increased number of automatic weapons and the probably increased mobility of reserves, present increasing advantage to a policy of defence in depth and reliance on reserves.

The time taken to develop the defensive system should be noted. It is unlikely that a coast line can be permanently protected against landing operations, and it should seldom happen that the defence would have so long or so definite notice as in this case. In this connection, General Aspinall-Oglander brings out in several places the opportunities that may arise in the course of a war to undertake opposed landing operations, which would be quite out of the question as an initial step when the enemy was not committed elsewhere. He points out also the greater chances of preparing an expedition during the course of a war, without the enemy's knowledge, as compared with the difficulty of concealing preparations at the outbreak of war.

A nation that has no other commitment has a comparatively simple task in perfecting its defences from overseas attack. When, however, it has other commitments, the potential invader has power not only to exercise great strategic influence, but is also likely to discover weaknesses in the defensive arrangements should definite action become necessary.

Part II deals with the execution of Sir Ian Hamilton's plan, and is the portion of the book which contains most lessons for the soldier reader. The complexity of the arrangements which had to be made with the Navy for the actual landing stand out. These complexities seem to have diverted attention to some extent from the difficulties which would be encountered both in securing the beaches and in making progress from them inland.

The underestimate of Turkish efficiency and an overestimate in the effectiveness of naval covering fire also must have influenced the tactical plan. The arrangements with the Navy appear to have been based on the desire to get as many troops ashore as was quickly possible at a considerable sacrifice of tactical organization and control. Presumably it was considered that re-organization would be effected after the landing.

The operation of landing in face of opposition is probably best considered in two phases, each of which presents its special difficulties.

The first phase is the actual landing of the leading troops on the beaches and the capture of the enemy posts, which can bring small arms fire to bear on them. Surprise, darkness or naval gun fire may be

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exploited to cover the approach to the beach. Once ashore, rapid and determined action by junior leaders must secure the primary footing, guided by clear orders issued beforehand.

There still remains the second phase of a further advance to secure a bridgehead position of sufficient depth to allow of the deployment of the main landing force. This covering position must be captured rapidly and without the assistance of the normal proportion of supporting weapons. The difficulties of this phase have increased immensely with the increased range and power of weapons, and a suitable organization for control is necessary.

The depth of the bridgehead and consequently the frontage to be secured have proportionally increased, while the effectiveness of naval covering fire must decrease rapidly as the advance progresses, owing to difficulty of observation and communication.

At Gallipoli, the first phase was carried through at the price of great losses and considerable delay, the absence of a floating reserve to exploit opportunities being a conspicuous defect. The second phase, at Anzac especially, was never really completed; the main force was expended in the attempt to secure the covering position. It was for the execution of the second phase both at Helles and Anzac that the orders and general plan appear most open to criticism, as they made the maintenance of control very difficult, and gave the O.C. covering forces tremendous tasks.

In the light of present-day doctrine it is interesting to consider whether the organization of the command of troops required to seize and hold the covering position could be improved.

In each case, at Anzac and at Helles, the covering position represented a frontage which either for attack or defence would have entailed the deployment of a whole division on a two-brigade frontage in a normal land operation.

Fighting was expected from the moment of landing, and therefore would it not be natural to deploy the Division on its battle frontage from the start? Was the idea of a special covering force with a single commander a somewhat stereotyped one, following the lines of the old doctrine of a special Outpost or Advanced Guard Commander?

At Anzac, the covering force was one Brigade and it was given an objective 6,000 yards in extent and an advance of at least 2,000 yards. Surely too great a frontage for one Brigade Staff to control without established signal communication and without horses. Moreover, the capture of the objective entailed an eccentric operation with the conflicting objects of flank protection and gaining ground towards the final objective. It is true a second Brigade was to follow and take over the protection of the critical left flank, but that did not relieve the O.C. covering force of the necessity of dispersing his Brigade initially.

A landing on a two-brigade front and the allotment of task accordingly would have given an organization in some depth. The Division Commander would then have been O.C. covering force, exercising his command through his two Brigade Commanders. They in turn would have been in the better position to exercise personal control, and devote their attention to their special task.

At Helles the same course in a more extreme form was taken. The

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covering force and its Commander, Brigadier-General Hare, were detailed by G.H.Q.

General Hare was originally made responsible for five widely separated beaches, and in addition to commanding his own 86th Brigade had four other Battalions drawn from three different Brigades under his orders. It was realized that this was an impossible task, and eventually he was relieved of the responsibility for the two flank beaches, the Division taking over direct responsibility for them. Even then General Hare had a heavy task, as his three leading battalions landed at separate beaches, and he had an extra battalion added to his reserve on the *R. Clyde*. This reserve being committed to V beach from the first lost its mobility.

The troops on the " S " and " Y " flank beaches were drawn from the 87th Brigade, and the R. Naval Division, but were not under a Brigade Commander.

It had been intended to land the 88th Brigade, so as to take its place on the right of the 86th Brigade and the 87th Brigade (less two battalions) as divisional reserve, on the left at " X " beach.

Eventually, troops of these two Brigades became superimposed on the 86th Brigade. General Hare became a casualty at an early stage in endeavouring to exercise personal control. General Napier, commanding 88th Brigade, was killed in attempting to land in a situation of which he had no information. The dispersion of the Brigades made it more difficult to replace these Commanders.

It will be seen, therefore, that the normal Divisional chain of Command was abandoned at the start, and could not be re-established for some time.

The Divisional H.Q. became absorbed in the control of the fight on the three main beaches, and appears to have lost touch with the two flank beaches, where successful landings had been made which afforded opportunities of relieving the general situation.

Here again it would seem that if the covering force had been divided into two Brigade sections, the task of the Brigadiers and of the Division H.Q. would have been easier, and its control more effective.

The employment of the *R. Clyde* was an afterthought, and she was expected to perform two functions. One was to provide close covering fire to the landing parties, and this demanded that she should be beached at an early stage. The second and more important was to convey a reserve which should not have been committed till the point when it could best be employed was determined. The *rôles* were, in fact, conflicting.

General Aspinall-Oglander dwells on the opportunity which he considers was lost on " Y " beach. No doubt both there and to a lesser extent at " S " beach opportunities occurred.

It would not appear that the opportunities were deliberately created, as each of the detachments was assigned a protective rather than an offensive *rôle*. They were to serve as a bait to draw off Turkish reinforcements, and offensive action by them was not suggested until they joined in the general advance. As the opportunity that arose had not been anticipated, Sir Ian Hamilton was unable to lay his hand on reserves with which to exploit it.

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Without reinforcement by reserves, neither had in reality much power of offensive action, as the force at each place was little greater than was required to secure the narrow footing obtained. It is possible that an advance from " Y " beach on Krithia might have affected the morale of the Turks opposing the main landing, but it appears more likely that it would have resulted only in the force being cut off from its landing place by Turkish reinforcements. Without artillery support, transport, or mounted troops to obtain information, radius of action was limited.

The fact that the 2,000 men landed at " Y " beach were numerically superior to the whole Turkish force south of Achi Baba at the time of landing is perhaps over-stressed.

What proportion of the 2,000 was actually available for offensive action? What degree of mobility did they possess? How far was their Commander tied by his orders, and how far was he handicapped by lack of Staff and responsibility for his own unit? This last factor must have been largely responsible for the ultimate misunderstandings which led to the withdrawal of the detachment.

Part III dealing with the attack subsequent to the first landing is a further record of the wonderful gallantry of the troops, but is of little value to the student.

The task was an impossible one without a degree of artillery support which the Navy could not provide.

The reader can hardly leave the book without speculating how far an opposed landing operation will be feasible in the future.

The increased proportion of automatic weapons and the air arm will increase the power of defence. Surprise will be more difficult. Transports, landing craft and crowded beaches will offer targets to air attack.

Mechanical transport will increase mobility of reserves of the defence.

Where the probable points of landing are well indicated and efficient arrangements have been made for defence by troops of good morale, the prospects of gaining a footing on the beaches must be practically *nil*.

On the other hand, the efficiency of the defence may still be affected by commitments elsewhere, the number of alternative landing-places and the lack of time to complete defensive arrangements, as was the case at Gallipoli.

The attack, too, has gained something. For the actual landing operation much will depend on the amount of naval air support, and whether an air base can be secured from which air support can be provided and local air supremacy obtained.

Naval gunnery against land targets has advanced, though it still must work under great disadvantages in dealing with points of resistance encountered inland and keeping touch with the position of the troops it is supporting.

More efficient landing craft and tanks may play an important part in gaining a footing on the beaches. It is, however, in the problem of securing the bridgehead position that tanks are likely to exercise a great influence. The necessary dispersion of the defence will make the anti-tank problem difficult, while the rapidity of tank action may anticipate arrival of reserves.

This book records how an operation, which had been examined during a period of peace and which had been turned down by military opinion as

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too hazardous to undertake, had to be attempted owing to circumstances which had not been envisaged.

We must conclude that the study and practice of landing operations is as much as ever necessary for a maritime nation, and this history must be read at least as an introduction to such study.

It is well to remember the statement made by Mr. Asquith, quoted in a footnote, p. 62 : " It is the duty of any Government . . . to rely upon the advice of its naval and military counsellors . . . but . . . sometimes it is not only expedient but necessary to run risks and encounter dangers which pure naval and military policy would warn you against."

C.W.G.

THE VICISSITUDES OF ORGANIZED POWER.

By The Hon. Sir John Fortescue, LL.D., D.Litt.

(Oxford, at the Clarendon Press, 2s. 6d.)

The Romanes Lecture for 1929 was not addressed to soldiers, but it will well repay them to read it. Sir John Fortescue took as his subject the growth and development of the organized forces with which peace and order have been maintained and are still maintained throughout the Empire. He emphasized a trait which seems to be peculiar to these forces of ours, that they are not overbearing nor arrogant in carrying out their work whether in war or peace. This characteristic he derives from the experiences of the British Army. Long years of trial and endeavour have bred in the Army a tradition of service, obedience, and sacrifice. The story of the growth of this tradition through the interplay of character and history is absorbing. The author claims that the chief influences are, firstly, two centuries of national hostility to the Army; then, the existence of the purchase system, which gave full play to the proprietary instinct so strong in the English country gentleman; and finally, the interaction of these influences on the British character. He closes with a tribute to the officers and men who have unconsciously inspired every soldier and constable, of whatever race and creed, with the spirit of the British Army. We should be proud to belong to a service which has inspired such praise, and of which it can be said that " possibly centuries hence historians may agree that through the peculiar schooling and character of the British officer and soldier, *Pax Romana* was eclipsed by *Pax Britannica*."

N.W.N.-C.

MILITARY ENGINEERING.

Vol. VIII.—Railways, 1929.

(War Office, London : H.M. Stationery Office, Adastral House, Kingsway, W.C.2. 8½ in. x 5½ in. 318 pp. and 49 plates. Price 2s. 6d. net.)

(Reprinted by permission from *The Railway Gazette*, dated 7th June, 1929.)

The manuals of military engineering have all been revised in the light of the experience gained in the Great War, and the necessity for this naturally applies with particular force to the volume on railways, since

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transportation in all its forms plays a supreme part in modern warfare. It is interesting to have the axiom laid down on the first page of this manual that "Railways have demonstrated their marked superiority over all other means of land transport as a means of moving large forces and material in bulk over long distances in a reasonable time." In spite of mechanized warfare, there seems no danger of motor competition here.

The manual is divided into three sections, dealing respectively with railways in war; operating; and engineering. The first section discusses generally the railway problem in a theatre of war, lines of communication, and repair and demolition of railways. Part II deals with operating principles, locomotives, rolling stock, layouts, signals, operating practice, control and emergencies. The third part covers location, earthwork and drainage, bridges, permanent way, track-laying and maintenance, and fixed equipment. The volume is amply furnished with illustrations, tabular and other data, and with a full index. It will doubtless be studied by engineer and railway reserve officers, and may, indeed, be recommended to railway officers and students generally as presenting a clear and straightforward account of operations which do not differ in principle as between military and civil practice. We note that the description published by *The Railway Gazette* of the construction of the Kassala line in the Sudan is quoted at length in an appendix.

PRACTICAL HORSEMANSHIP.

By Captain J. L. M. Barrett, 13th/18th Hussars.

(H. F. & G. Witherby (1929), Price 12s. 6d.)

This book is written for the novice of all ages, and contains chapters on advanced work and practical hints on horse and pony buying.

The great art of training and riding a horse leads to many various ideas and theories being put in print, and the author rightly says in his preface that "riding" is a very "controversial subject." Captain Barrett starts away right at the beginning of things with his novice, and outlines the course of instruction which should be given to the beginner, and gives his ideas on the various essential attributes which go to make the complete and finished horseman, illustrating his remarks with photographs which are, in most cases, excellent, and any novice who is really imbued with the determination to ride a horse well, will be well advised to adhere to the course laid down for him, and to imbibe the theories explained in these chapters.

Very great stress throughout is laid upon learning to "jump" properly, though insufficient reasons are given for this greatest and foremost essential in learning to ride. The author draws a rather exaggerated picture of our forefathers' horses, every single one of which became "either (1) a confirmed refuser, or (2) that despicable type of animal that would not jump in cold blood, or (3) he put up with it, and was worth a fortune to real bad horsemen with a lot of money." Though these bare statements are believed by many who study the subject in the light of modern teaching, they are not convincing to those who are now learning, and who are surrounded by fathers and mothers of the old school, and which latter local authorities have to be primarily convinced of the

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soundness of modern teaching by good sound argument, which is, in this book, somewhat lacking as a foundation for the very sound principles advocated.

The chapter on " hands " is extremely sound in the very limited length to which it goes, insufficient being said about fundamentals, such as the position of these very important portions of the rider, whether they should be kept with the palms upwards or with the palms downwards, and how they should move when brought into action. Merely a few general remarks as to where the hands should be held and in what general manner they should act in relation to the horse's mouth. The real novice requires to know much more than is given here, and further, the general actions so strongly advocated by the author cannot be properly produced by a horseman who holds his hands upside down, even though they are " placed as low as possible, without appearing set or fixed, over the withers, with the wrists slightly rounded." There are no less than three separate and distinct positions in which the hands can be held, which comply with these vague words, and only one of which is the one the author means. In short, Captain Barrett has in this subject fallen deeper into the pit which he describes in the opening sentence of his chapter than most authors.

The chapter on advanced jumping falls necessarily under the heading of " controversial," and it is difficult to follow why one, whose earlier chapters are full of such sound teaching, so obviously the result of good reasoning, should be so easily led into giving the plausible arguments which Captain Barrett sets down in his explanation of what he calls " The 2nd Method—The Foreign Style," or in plain English, the method of " leaving it to the horse."

Singularly unfortunate is the choice of example, as Captain Barrett quotes " Lieut. Bizard, the brilliant French Army horseman," as the best illustration of this particular method, and in doing so, his choice has fallen upon one of the world's greatest artists in " timing." Those of us who were privileged to watch Lieut. Bizard riding his young horse Arcachon to victory in the *Daily Mail* Champion Cup at the International Horse Show at Olympia this year, would find it a hard task to reconcile that consummate display of skill on the rider's part, with the picture drawn of him in this book. The author seems to have fallen into the pitfall of assuming that a very fine horseman is doing nothing, because he is doing a great deal so quietly and so nicely, as to be inaudible to the gallery and invisible to those who are not very closely attentive. It would be interesting to know what Lieut. Bizard would say, did he know that he had been quoted as one who advocated " leaving it all to the horse," even to the extreme of making no effort to keep his horse balanced in the last few important strides of the approach.

In the two chapters on difficult horses and bitting, a great deal of sound advice, only partially supported by reasoning, is to be found by the novice and the author brings a new question into the field of controversy by stating that " it is useless to punish a horse *after* a refusal," a theory put forward and advocated by no other authority on the subject.

Captain Barrett's " Hints on Buying Horses for Beginners " is a first-class chapter, and should be read, and the lessons of it should be learnt by heart, by all novices at this very difficult art.

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Practical Horsemanship is full of very sound advice to the novice, as to how he should set out to learn to ride a horse, particularly if discussed with some knowledgable person who can throw light on the more controversial points, and give sound reasons for the methods advocated, but it is a book which should be in the possession of all, novices or those with more experience, who have at times to buy themselves horses. They would be well advised to read through the chapter on buying horses on every occasion before setting out on that fateful expedition.

———— S.A.H.B.

LES INONDATIONS DU FRONT BELGE (1914–1918).

MAJOR DU GÉNIE R. DEGUENT, Professeur à l'École d'Application de l'Artillerie et du Génie de Bruxelles.

(With photographs and sketches. Paris Edition, Berger-Levrault.)

The substance of this book has already appeared in the form of articles in the *Revue du Génie Militaire*. A précis of these articles appeared in the following numbers of the *R.E Journal*: December, 1928; March, 1929.

MAGAZINES.

REVUE DU GÉNIE MILITAIRE.

(*February.*)—An article entitled "The Economical Employment of Engineers in 1928" describes various works of practical utility on which Engineers were employed in accordance with the standing orders for the training of that branch of the Service, of which the following is an extract: "Chief Engineers will take every opportunity of employing their troops on works of real utility. To this end they will negotiate with landowners, civilian contractors and communes, and will arrange for the units under their command to carry out works of a public or private nature."

For example: in July, the 2nd Regiment was sent to the Alps to widen from three to six metres the formation of the future road from Peille to the Col de Segra. In August, the 17th Regiment, on the application of the autonomous port of Strasbourg, sent a detachment to dismantle the two footbridges over tributaries of the Little Rhine and construct a pile footbridge over the Brunnen-Wasser. The 15th Regiment provided detachments to construct a light railway to the camp of Bitche and to lay 1,400 metres of light railway from Cerisier-Signal to the main line. The 17th Regiment, on behalf of a civilian contractor, blew up a barge loaded with stone which had foundered in the Rhine. The 33rd Battalion (Levant) constructed a post at Zélaf, 80 kilos east of Souéida.

Interesting photographs of many of the works are given, including some of those carried out after the floods and cyclone in Algeria.

There are also articles by General Normand on the systems of fortification practised by Vauban, and a description of a suspension bridge for vehicles of 2½ tons by Captain Pinson.

(*March.*)—Chef de bataillon Tournoux contributes an article called "Ideas on permanent fortification, the importance and object of permanent *points d'appui*." In it he describes the fighting which took place during the recapture by the French of Fort Douaumont. It had been

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abandoned by them on Feb. 25th, 1916, after being disarmed, under the mistaken idea that permanent works were no longer of any value. A vivid description is given of its bombardment by the French and its recapture on May 24th.

The successful attack made by the Germans on May 27th, 1918, on the 13-kilo-long position of the Chemin des Dames is cited to show how valuable a system of concrete *points d'appui* would have been.

The defence of Froideterre, situated at the end of the long ridge which stretches from Douaumont to the south-west, is described. It was a small permanent work intended for a garrison of 142 men, with two turrets for machine-guns, and a turret for a 75. Like the other works at Verdun it had been disarmed, but was given a garrison of 134 officers and men and 8 machine-guns. It was heavily bombarded from June 21st, and assaulted on June 23rd, 1916, but put up a successful defence until a counter-attack drove the Germans off.

" The railway from Thiès to the Niger," by Chef de Bataillon L. J. R. Faure. In the November number of the *Revue* there was an account of the construction of the railway from Thiès, near Dakar on the coast of Senegal, to Kayes, on the Senegal River. A line had previously been constructed between Kayes and Koulikoro on the Niger, so that after the completion of the first mentioned line there was through communication between Dakar and the French Soudan at Koulikoro. It was hoped that the rapid economical development of the Soudan and an ever-increasing traffic would follow. This expectation has only been realized in part owing to the inferior construction and indifferent management of the older line, which was begun in 1882 for strategical purposes.

This article describes the measures taken and to be carried out to put the Kayes–Koulikoro line on a proper footing.

This number contains an obituary notice on General Normand, whose death occurred on March 7th as the result of an accident. He was a most distinguished engineer officer, and became *Directeur du Génie* at the Ministry of War in October, 1927.

(*April.*)—" Passage of the breach of Villeneuve, near Soissons," by Colonel Lastours, contains an account of the repair of the railway bridge over the Aisne at Villeneuve, between Soissons and Laon, in April, 1917. The bridge consisted of three masonry skew arches of 21·75 metres span, of which the two southern arches and the southern abutment had been destroyed. The piers were rebuilt in concrete, and the broken abutment replaced by a pier and a short span on to the bank. " Marcille " girders (steel plate) were used to replace the arches. The work was carried out under considerable disadvantages, as the site was at first under machine-gun fire, and for the whole time was liable to bombardment. In May, 1918, the French failed to destroy the bridge in their retreat, but the Germans made no such mistake in September. The " Drainage of an Aerodrome," Lt.-Colonel Grellier, describes how the level of the subsoil water under the aerodrome at Pruniers, near Romorantin, which stood 10 cm. below the surface, was lowered by about half a metre.

This number contains a translation of the article by Lt. J. C. R. Fitzgerald-Lombard on " The Work of a Mechanized Field Company during Divisional Training," which appeared in the December number of the *R.E. Journal*. A.H.B.

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MILITARWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*November-December number, continued.*)—*The Influence of Propaganda amongst Prisoners of War in Russia upon Austro-Hungary's Collapse.* The writer of this article, having been deputy-chief to the Austro-Hungarian War-prisoners' Mission in Russia, had special facilities for making enquiries as to the propaganda among the prisoners. He arrives at the conclusion that the immense influence of the Russian revolution upon the subsequent course of internal political events in the states of Central Europe could only in a very slight degree be attributed to those who returned from captivity, since the revolutions in Austria and in Germany originated in those industrial circles which were least in touch with the army, and hence with the returning prisoners. It is curious that he does not mention the fact that very many of the prisoners were unable to get away from Siberia until long after the revolutions had taken place.

The last Battle of the 12th Mounted Rifle Division. The commander of this division (now a Lieut.-General in the Polish Army) writes a short diary of the division's doings from the 26th October, 1918, when, in the final Allied offensive on the Piave, it was attacked in the Sergnalia sector, to the 11th and 12th November, when, after having been the last body of troops of its size to cross the Austrian frontier, under arms and with military discipline, the four brigades entrained at Tarvis for their respective demobilization centres (8,000 strong with 4,000 horses).

The account claims to prove that formations, even when composed of troops of different nationalities (in this case Austro-Germans, Czechs, Poles and Hungarians), if trained on well-established principles, and led by officers imbued with the spirit of arms and keeping themselves apart from politics, will do their duty to the utmost.

Soldiers will find the account interesting as one more example of what military history has taught throughout the ages, viz., that a high enough military spirit can fuse together quite discordant elements.

Railway Services during the Collapse in the autumn of 1918. The railways of the Austro-Hungarian Empire, which had fulfilled all requirements during mobilization and for over four years of war, found their most difficult task with the homewards flooding of troops from all fronts.

Demobilization instructions had indeed been drawn up in 1917, laying down both principles and preparatory measures, but they were based upon the idea that peace would follow an ordered armistice. When the collapse came, the result was chaos on the railways. Only the self-sacrificing work of the railway personnel was able to effect in barely four weeks a mass movement which had been calculated according to plan to take five months. The cost was enormous, both by destruction and loss of army material, much of which fell into the hands of the quickest grabbers and other war-hyenas.

Submarine Warfare, 1914–18. This article is responsible for the statement that Germany lost 763,000 lives in consequence of the hunger-blockade: otherwise it discloses little that is new. It quotes both Lloyd George and Lord Churchill (*sic*) as evidence that Great Britain only just escaped being defeated by the unrestricted use of submarines, started by Germany on February 1st, 1917; and points out that it was the

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United States which saved us, by providing the destroyers necessary for the convoy system, which defeated the submarines.

In complaining finally that the cruel words "Too late!" must be written over Germany's last, powerful, and hopeful attempt to finish the War in honour, even if not in victory, the author (a sailor) disregards—he could hardly overlook—the great land offensive of 1918.

The Civil War in China. The narrative by General von Mierka is continued. It covers the entry into the War of the Governor of Shansi (brought about by one of his subordinates starting hostilities against Chang Tso-lin): the events of the winter of 1927-28, from Chiang Kai-Shek's return to the great Customs Conference in March: the quite thrilling campaign of 1928, up to the death of Chang Tso-lin: and the Mongol effort against Khailar. The author knows his East, throws instructive sidelights, and is always clear and entertaining.

The Offensive in Wood-fighting.—Consists of two examples of wood-fighting on the Russian front, from which Lieut.-Colonel Kissling deduces that, while increased weapon-effect has changed tactics elsewhere, the tactics of wood-fighting, in which tanks and aircraft play no part, has remained unchanged.

The Italian 12-in. Howitzer. Major Heigl interrupts the ordered sequence of his series of articles on artillery-material to describe what is both the most powerful gun used against the Austrians during the War and still the best of its kind. The 30·5-cm. Howitzer L/17 was originally designed for coast defence, but the Austrians knew before Italy entered the War that thirty of them had been made mobile for the field. Of this number, at least fifteen fell into Austrian hands during the 1917 advance. The Austrians got out new tables, and took them into use. Since the War, the range has been increased by improved projectile from 14,600 metres to 17 kilometres. L/17's construction in many ways points to its English origin, as a product of the Armstrong-Pozzuoli works in Naples (*e.g.*, wire-winding, enlarged rear end of chamber, method of breech-closing), and Major Heigl feels impelled to suggest that the excellent quick-loading arrangements (which appear again in the new American 16-in. coast defence gun) were purposely neutralized by breech-closing arrangements (three motions), which even in 1912 were out of date, because Italy was at that time Germany's ally.

The photographs show the 12-in. howitzer on the line of march, in the firing position (ordinary mounting), and in the firing position as mounted by the Austrians.

The Motor-lorry as Railway Engine. A demonstration was held at the end of last year at Korneuburg, before the Press and other interested persons. An ordinary four-wheeled motor-lorry has its fore part carried on an eight-wheeled bogey, and the steering becomes automatic. The bogey and the railway trucks run on the rails, while the lorry's driving wheels run on the metal outside the rails. For this system is claimed that it combines the good properties of the wagon which runs economically on rails, and of the motor-tractor on a road, which provides a good tractive performance as a result of the great friction between wheel and road surface.

The disadvantage of the ordinary train, viz., that the tractive-power depends on the weight of the locomotive, and the disadvantage of the

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motor-lorry on a road, viz., that on account of steering and braking difficulties it is not able to tow more than one trailer, are both done away with. As no great adhesive-weight of the engine vehicle is necessary, lighter rails can be used, and both rails and general construction of field lines are sufficient for the motor-lorry engine system.

The whole, especially the automatic-steering bogey, has been worked out by Major-General Tlaskal, formerly D.M.T. in the Austro-Hungarian Army. Practical use has been made of it in Uganda, the Transvaal, Rhodesia, Australia, India, and other British colonies and dominions, also in Scotland, in Spain, and in the Spanish theatre of operations in Morocco.

For steep slopes and soft soil the wheels have been replaced by caterpillars, also having automatic steering.

The mounting and dismounting of the lorry takes two men four to five minutes. At the demonstration, automatic steering functioned perfectly on 10 metre radius curves at a speed of 18 m.p.h.

The system is recommended as doing away with the necessity for locomotives on lines where there is little or only periodical traffic, the lorry being available for road work in the meantime, and especially for military purposes for getting lengths of light railway quickly into use.

The French new Medium Tank.—The *Bulletin Belge* announces as under trial in France a 20-ton tank which carries a field-gun as well as four machine-guns. From Poland also, the replacement of the old Tank Mark V* of the War by a 20-tonner has been confirmed.

The appearance of such a tank, especially in France, is sensational, since it appears to be directly in opposition to the views of the French school. The explanation is possibly that the new light tank, which from English sources is reported to travel up to 37½ m.p.h., is too weak to take the field against strong anti-tank defence, except under special protection.

The English new Six-wheelers.— Quotes from a lecture by Major Kuhne at the R. United Service Institution, and shows a photograph of a six-wheeler car carrying 10 men on four transverse seats, the pairs of which face inwards as in railway carriages.

An interesting feature is the provision of a small fourth pair of wheels, near the driver's feet, the object of which is to engage when crossing ditches, and thus prevent the fore-wheels from falling in too deeply.

Tracks are carried on both sides above the four rear driving-wheels, so that the car can be quickly converted to half-track.

As regards the provision of bullet-proof pneumatic tyres, the English are not so advanced as the French or the Czechs.

All these 6-wheel vehicles, with two axles driven, give very satisfactory results across country as long as the country is not altogether too rough.

F.A.I.

COAST ARTILLERY JOURNAL.

Mention was made in the June issue of the *R.E. Journal* of an article on the World Coal Situation contained in the December number of the *Coast Artillery Journal.* On April 9th, *The Times* called attention to Britain's lag in electrical power, and mentioned the World Power Conference which proposes to " establish standard methods and values for

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assessing the power resources of the world, to obtain such methods and values through the collaboration of 48 countries, and to carry out as rapidly as possible a survey of the world position on this basis."

The Conference has just published an initial volume—*Power Resources of the World, Potential and Developed*—which gives details of the basic work carried out in those countries, including the British Dominions, United States, Central European States, Germany, Holland, Russia, China and Chile. The opinions, as far as they can be obtained in the early days of the research, vary considerably: the estimates of the world's coal resources vary from $5\frac{3}{4}$ to $10\frac{3}{4}$ million million tons. From the coal output of 1927, it is roughly calculated that the coal reserves of the world will not be exhausted for some 4,000 years, at the present rate of production. This rate of exhaustion varies from about 50 years in some European countries to a very far distant age in the case of the United States.

The exhaustion of the oil fields, on the other hand, is mentioned as being within sight, 40 years being one estimate.

The most accurate estimate, however, seems to have been made with regard to water-power, though a great deal of co-ordination is still required to obtain any working basis. The latest figure given appears to be in the neighbourhood of 500 million H.P.

The world's output of electrical energy is reported to be 190,000 million units, of which the United States control nearly half, while Great Britain's portion is only about 5%. Great Britain's present rate of progress, even, is less than that in the United States, Germany, Canada, Italy or Switzerland, so it is hoped that the proposed national power scheme will soon begin to make up for lost time.

Germany, Russia, France, Spain, Italy, Belgium, Austria, Czecho-Slovakia, Hungary, Greece and the Dominions all propose to carry out ambitious schemes for the complete electrification of their countries with a view to decreasing the cost of production of their industries.

The American Bureau of Mines finds that the percentage of power derived directly from coal, when compared to the power derived from electricity, oil, gas, etc., has fallen from 88·5% in 1913 to 77% in 1927. Electrical power, on the other hand, has increased its ratio from 3·4 % in 1913 to 11 % in 1927. Economic values are rising ever more rapidly.

The March number continues the historical narrative of the origin and gradual growth of the system of coast forts along the South Atlantic.

In the same number there is also an article entitled " Ships on the Battlefield," concerning the use of tanks in land fighting. Last November, the new Christie tank of the U.S. Army Light Tank formation covered 144 miles along a road, " between breakfast and lunch," though the actual time is not stated.

After the description of a manœuvre between a combined, unarmoured, unmechanized Corps of all arms and an up-to-date mechanized force, in which the light tanks irrupted unannounced into the cavalry screen and broke it up, the author deduces two lessons. First, that " cavalry should be the first to recognize, teach and apply the improved methods which fast, cross-country fighting machines will provide," to assist them in their work. It will be remembered that some of our own cavalry regiments have already been transformed into A.C. regiments. And secondly, that

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" changes in tactics, far more radical than those caused by aircraft, have come to stay."

The May number contains an article on the rôle of the new 37-mm. AA gun which has been under trial. This weapon fires a shell with a fuse sufficiently sensitive to produce detonation on contact with the fabric of an aeroplane. A hit on any part may therefore disable it and put it out of action. The fuse is provided with a time scale to ensure detonation in the air, so as to preclude eventual danger to ground troops and others from heavy falling missiles. When compared to other AA weapons, its performances are as follows: Max. vert. ranges: 3-in. gun, 16,800 ft.; 37-mm. gun, 10,000 ft.; 50-cal. M.G., 6,000 ft. Max. hor. ranges: 3-in. gun, 5,400 yds.; 37-mm. gun, 3,000 yds.; 50-cal. M.G., 2,000 yds.

For use at minimum ranges, the 37-mm. gun is as easily manipulated as the heavy machine-gun: it is capable of picking up an enemy plane in a few seconds and delivering directly-aimed fire till overhead, and can be used against targets flying under 1,500 ft. It is furnished with tracer ammunition. It could probably deny effective enemy observation under 9,000 ft., and would thus be of use only in the forward areas in place of the machine-gun. And even for this quick work it is hampered by its present mounting on a trailer which has to be towed. It must be placed in position before it can deliver fire, and must be dismantled to return to the road. When in position, its covering power compared to the M.G. is as 12 is to 8. It would, therefore, seem to be useful only as a more efficient machine-gun if made more truly mobile.

There are two detailed articles on the care of seacoast armament when laid up, giving instructions which have been proved in practice and found to give good results: the whole trend of the article is to cut down the numbers of caretakers by centralizing the safe storage of all moveable parts.

In a well written essay on " Imperial versus National Sea Power," the author traces the present " agreement to disagree " in the matter of cruisers, to the announcement in 1920 that Great Britain would be satisfied with a one-power standard as regards her navy. It will take time for the average Englishman to become reconciled to this great departure from his long-standing tradition, for tradition is part of his being. The present difference of their needs is stated lucidly. " It is a fairly accurate generalization to state that, while the British Navy exists to fight, the American Navy exists to avoid fighting." " With reasonable steadiness in Washington, we need have no fear of a *casus belli* from London." " The naval needs of the United States . . . are in some measure fulfilled by a fleet in being, rather than by a fleet in action."

The former articles on Colonial Forts are followed by one on " The Colonial Forts on the Pacific Coast." Vasco Nunez de Balboa discovered the " South Sea " in 1513 and annexed for Spain the whole ocean and all lands washed by it; some gift, even for His Most Catholic Majesty of Spain. Magellan made the South Pacific a Spanish lake, and Cortes strengthened the hold of Spain by the military occupation of Mexico and California. In 1542, Juan Rodriguez Cabrillo confirmed possession by the discovery of San Diego harbour and his expedition reached Cape

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Blanco in Oregon. The lure of gold and gems beckoned the Spaniards on to twenty or more voyages along the coast up to the forty-third parallel of latitude or about Cape Blanco, but without permanent occupation; Estevan Jose Martinez in 1788 reached the sixtieth parallel and examined the Russian settlements as far as Prince William Sound.

Meanwhile, other discerning eyes found the same attraction when Francis Drake made his memorable voyage in the *Golden Hind* in 1578. Though it was not till 1778 that England was again upon the scene, when Capt. Cook mapped the far north-west from Norton Sound through Bering Strait to Icy Cape, beyond the seventieth degree of latitude. From that time the Pacific shores were well known to British, French and American navigators.

But all this time the Russians had been creeping in from the north-west. In 1728, Vitus Bering sailed through the strait that bears his name, and found that Asia and America were not united by land. Many others followed, but without lasting success till about 1769, when Levarscheff established Russia's claim to Alaska.

In 1769, Spain made her first real attempt to oust all her rivals by fortifying San Diego and Montery; in 1770, the harbour of San Francisco was discovered by Don Gaspar de Portola, the military governor of California. The settlement consisted generally of a religious mission protected by a small garrison, the frontier being guarded by a line of small forts or "presidios." Later, the defence of each presidio was increased by a battery of eight twelve-pounders. These were in various states of preparedness or decay, according to the spirit of the commander of the occupants. Some of the details of the garrisons in 1773 are illuminating; at Montery, the capital, there were a Commandante, a serjeant, two corporals, twenty-two soldiers, two carpenters, two blacksmiths, four muleteers and a storekeeper: at San Diego, the same garrison, but in the charge of two serjeants; while for each of the five principal missions there were five corporals and twenty-five soldiers.

San Francisco was occupied in 1776 and Santa Barbara in 1782. At the first important inspection of the coast defences, by Governor Jose de Arrilago in 1792, it was found that there was only one small gun of questionable serviceability at San Francisco, while at Montery there were certainly more guns, but no gunners to work them. His successor in 1794 found that San Francisco and Montery had a few guns, but that the rest of the province was quite defenceless: and what must have disturbed him was the fact that his sovereign had just declared war on France. He had less than 300 soldiers in the whole country, and they were scattered in twenties and thirties all along the coast.

The fortifications seem to have still been so neglected in 1803 that a British brig, mounting six three-pounders, put the forts at San Diego out of action in three quarters of an hour. There were but eighteen artillerymen assigned to about the same number of batteries dispersed along the seaboard of California.

In 1812, the Russian governor of Alaska sent a force of about one hundred Russians and a hundred Indians to establish a settlement at what is now known as Bristol Bay, and form a trading post for the Russian-American Fur Company, but in 1841 they abandoned the site.

In 1818, two privateers under a Frenchman named Hippolite Bouchard

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stormed and carried the forts at Montery, destroyed the presidios and plundered the inhabitants. After he had put to sea again, the forts and the presidio were rebuilt on up-to-date lines and were put into good condition for the first time. In 1822, Mexico became independent, with California as one of her provinces. In 1824, a Russian explorer, named Kotzebue, entered San Francisco Bay, and, according to his own statement, had to lend the governor of Fort San Joachim the powder with which to fire a salute in his own honour.

In October, 1842, Commodore Thomas Jones, of the U.S. Navy, commanding the frigate *United States*, together with the sloop *Cyane*, entered Montery harbour, thinking that Mexico was at war with the United States. He captured the fort and raised the American flag before he discovered his mistake. The next day he hauled down the flag, apologized to the Californian authorities, and sailed away. The master of the American ship *Alert* did much the same thing at Point Guijarros.

War was actually declared by Mexico against the United States in 1846, and Commodore Sloat, commanding the American Pacific squadron, was ordered to secure possession of Upper California. He landed and seized Montery, Yerba Buena and San Francisco, the Sacramento forts, Bodega and Sonoma without a fight, and California was ceded to the United States by the treaty of 1848.

The forts further north on the Colombia River and Vancouver were merely fortified trading posts to protect the activities of the Pacific Fur Company and the North West Fur Company, which became amalgamated in 1821 into the Hudson Bay Company. In 1856, the treaty between Great Britain and the United States fixed the forty-ninth parallel as the permanent boundary between America and Canada.

In 1741, the first Russians, Chirikoff and Bering, brought back such beautiful furs from an expedition across Siberia to Alaska, that they roused the envy of Russian traders and trappers, so that, in 1784, the strong Shelikoff Trading Co. established its first settlements on Kodiak and Atogniak Islands and in Cook Inlet. Later on, a rival firm, the Lebedeff-Lastochkin Co., fixed its permanent headquarters in Cook Inlet also. The history of these various fortified posts surges backwards and forwards in guerilla warfare between the Russians and the Indians for years, a tale of sanguinary massacre and reprisal. In 1833, the Hudson Bay Co. fitted out an expedition to establish a post on the Stickeen River. Baron Wrangel, the Russian governor of Alaska, got wind of the attempt and dispatched an armed brig to anticipate the British. When the unsuspecting fur traders sailed into the harbour they were greeted with a sudden volley of heavy fire from the Russian ship, as well as from a fort on the shore. The British were forced to withdraw to Vancouver. This attack provoked a diplomatic incident between the two countries, but was settled in 1840 by the payment of an indemnity by the Russians and the lease of the land to Hudson Bay Co.

Finally, after a period of continuous Indian warfare, Alaska was sold in 1867 to the United States for seven million, two hundred thousand dollars.

In an article on the "Activities of Anti-war Societies," the author mentions a list of eighty-seven organizations in the United States, each complete with its board of directors and salaried officials, in well-equipped

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offices and with a membership ranging into millions. Their main class of propaganda is religion or communism. Their method is to affiliate with foreign organizations of a like nature and develop an international pacifism, and to use this influence to begin with a reduction of armaments, leading progressively on to the abolition of all armed forces.

The assistance of the sincerely religious pacifist is heartily welcomed by the communist at present; they are both pushing in the same direction to begin with. So were Lenin and Kerensky. But in their final aims they are widely separated, and the honest pacifist will be thrown over, to his own undoing, when the time is ripe for the more deadly work which is, as yet, unseen.

In the April number is an interestingly written historical account of "The First American Offensive," when Washington led his forlorn hope against the hitherto victorious British at Trenton at Christmas, 1776.

The Continental Army was scattered beyond the Delaware, and a bitter winter had set in. Spies were numerous and busy on both sides. Gen. Grant at New Brunswick knew on the 24th December exactly what Washington had said at a very secret conference of the American leaders a few days previously. Washington's scouts, in the guise of loyalists, mixed quite freely with the British High Command.

Washington decided to attack the Hessians on Christmas night, and trust to his staunch allies, supine self-confidence and soothing Christmas fare. The watchword was "Victory or Death." Though the Hessians had been warned of an impending attack, the surprise was complete, and the issue of the engagement was settled within the hour. Of the attacking force it is reported that two were killed; of the defenders, the commander and about a hundred men were killed, about a thousand were taken prisoners, and the rest escaped.

This was the first of the victorious events which culminated at Yorktown.

D.M.F.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1929. TOME I.—NOS. 1 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge (1914–1918). The account of the Line of Communication services during the trench-warfare period is continued in No. 1. The matters dealt with are those which relate to the medical services; the duties allotted to the "Inspection générale de l'armée" created in September, 1914; and the transport services. When the Lines of Communication of the Belgian Army were extended to the Base formed in France, the main responsibilities of the "Inspection générale de l'armée" were those connected with recruiting boards, training centres and the depots for convalescents. The routes utilized for the supply services, and the measures adopted for the defence of the same, are briefly touched upon, and a short account is given of the part played by the railways and internal waterways in meeting the requirements of the Belgian Army. The Belgian State Railways remained under civilian control and management after the outbreak of war, and the Chief of the Railway Administration made the necessary arrangements for meeting the needs of the Belgian High Command. In 1914, the only military railway unit in Belgium was a company attached to the fortress troops in Antwerp; during the first few weeks of the War, this

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company was not employed on duties connected with the transport of troops or supplies. When the Belgian Base was established in France, an International Commission, consisting of representatives of Great Britain, France and Belgium, was created, with Headquarters at Calais, for dealing with the railway requirements of the troops on the Western Front. As the War progressed, developments naturally took place in order to provide for the increased needs of the Belgian Army in relation to railway transport. Eventually, Commissions were created for the management of the railways, and for the control of the traffic arrangements and staff. The railway troops were also increased, and when the Armistice was signed in 1918 the Belgians had an engineer railway battalion (4 companies—total strength 2,000 all ranks) ; a field railway section ; a light railway section ; and a platoon for traffic duties.

A supplementary account of the Battle of the Yser appears in Nos. 2 and 3. It deals with the struggle in the Tervaete bend on October 22nd, 1914, when the Germans managed to force the passage of the Yser. It has been felt that, in view of the fierceness of the fighting, the critical nature of the situation created by the temporary success of the Germans, and the heavy casualties suffered by the Belgians, a more detailed account of these operations than that already published is desirable ; accordingly, the result of a further study of the events of the day in question is now placed on record in the two numbers of the *Bulletin* referred to above.

Avant-Postes réduit. This article appears in No. 1. Colonel De Haene, its author, points out that the reduction, in given circumstances, of the force employed on outpost duty is by no means a novel idea, the old regulations and instructions of the Belgian Army having tacitly recognized that a reduction in the *normal* strength of an outpost line might occasionally be permissible. What is entirely new is the fact that, in the recently issued Belgian Service Manual and Books of Instruction relating to the tactical training of the troops, definite and explicit rules are laid down on the subject. Colonel De Haene bases his discussion of the matter on the specific articles—which are duly indicated— on the subject contained in the official Belgian publications.

Emploi de la défense terrestre contre aéronefs. This article is contributed by Colonel Molhant, and appears in No. 1 of the *Bulletin*. The general principles of anti-aircraft defence are briefly stated. Colonel Molhant divides the defended area into three zones, viz. (1) *the forward zone* ; this is the area extending along the fighting line, and has a depth of 10 km. ; it is continuously under hostile artillery fire and under constant attack by enemy aircraft. (2) *The rear zone* ; this is the area contiguous to the first named, and reaches back to a depth of 40 km. from the common boundary of the two areas ; it is subject only to intermittent attack by enemy aircraft ; and (3) *The interior zone* ; in this zone, enemy action takes the form of raids at more or less wide intervals of time. Colonel Molhant sets out the nature of the defensive measures, which seem to him to be most suitable for adoption in each of the zones in question ; he further discusses the problem of anti-aircraft defence in relation to Belgian territory, and the Belgian Army. It is pointed out that at present only a very weak and inadequate anti-aircraft defence force exists in Belgium, and it is urged that, in view of the proximity of the

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important Belgian industrial and commercial centres to the frontiers of adjacent countries, measures should, without delay, be taken to remedy the deficiency in relation to this branch of the national defence. Colonel Molhant also desires to bring home not only to the civil authorities, but to the whole population, the peculiar nature of the dangers associated with air attacks, so that schemes for providing the necessary protection against this form of attack may be worked out in good time and be ready for instant adoption.

Les armées dans les Alpes occidentales. The second and third parts of the article under this title by Major Delvaux are respectively published in Nos. 1 and 3 of the *Bulletin*. The second part deals with the passage of the Alps by Hannibal. The subject is treated, *inter alia*, under the following heads: the character and manners of the Carthaginians; the military power of Carthage; the causes of Carthage's weakness during the struggle with Rome; the Revolt of the Mercenaries; Livy's character sketch of Hannibal; Hannibal's election, at the age of 26 years, to the command of the Carthaginian Army in Spain on the death of Hasdrubal; his success at Sagunto; the march on Rome; the forcing of the passages across the Pyrenees and over the Rhone; the conflict with hostile tribes, nature and the elements during the march across the Alps. Hannibal's Army, much attenuated, eventually camped in the Valley of the Po, but, in order fully to reap the fruits of the arduous march across Italy's mountain barrier, it was necessary that a decisive military success should be gained; nothing less than that Rome should be occupied. However, this prize proved to be out of Hannibal's reach, and, in consequence, Victor Hugo's paradoxical saying concerning Napoleon—*il était vaincu par sa conquête*—is, Major Delvaux points out, equally applicable to the Carthaginian general.

The third part of the article deals with the passage of the Alps by Napoleon; the subject is discussed, *inter alia*, under the following heads: the creation of the Reserve Army in January, 1800; the principle of the division of powers and ministerial responsibility, whereby it was ruled that the First Consul could not directly command the Army; Marescot's reconnaissance of the Alps in the early spring of 1800; Napoleon's plan of campaign; the final instructions to Berthier; the passage of the Alps by the Reserve Army; the resistance put up by the defenders of the Fort at Bard, and the construction of the improvised route *via* Albaredo in order to turn the enemy's position; and finally, the arrival of the French Army in the plains of Lombardy.

L'offensive. Progression au contact d'une division chargée d'une attaque de flanc. The original article is contributed to No. 2 of the *Bulletin* by Colonel Hans, who discusses therein the question whether, on the outbreak of another important war, the belligerents are likely soon after the commencement of hostilities to be forced to adopt trench-warfare, or, on the other hand, a war of movement will be possible. Colonel Hans brings under review some of the recent foreign literature dealing with this matter, and, at the same time, comments on the doctrines inculcated in the German and Belgian Service Manuals.

Tannenberg. D'après les ouvrages officiels allemands. The second and third parts of the article under this title, by Captain Vandaele, are published respectively in Nos. 2 and 3. In the second part of the article

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an account is given of the successful operations carried out by the Germans against the Corps operating on the flanks of the Russian Army of the Narew. The situations of the two Armies are set out, and the steps taken by the German High Command on August 24th and 25th to solve the problem before it are explained. The operations of the German I and XX Corps on August 26th, 1914, which resulted in the victory near Usdau, and those of the German XVII Corps and I Reserve Corps on August 26th and 27th, which resulted in the victory near Gross Bössau, are described.

The third part deals with the operations by which the isolation of the Russian Centre was effected. A description is given of the general attack of the German forces against the various fractions of the Russian Army on August 28th, and the pursuit of the latter on the following day. Maps, which clearly indicate the important situations, are provided.

Les opérations de l'armée belge (1914–1918). The account of the operations of the Belgian Army during the period of the stabilization of the battle fronts is begun in No. 4 of the *Bulletin*. In introductory paragraphs, it is pointed out that, although it was on rare occasions only during this period that attention was publicly called to the operations in progress on the part of the Allied Front held by the Belgians, nevertheless this section of the line was far from being a *secteur de repos*. The many difficulties encountered in the region of the Lower Yser, and the special arrangements which had to be made owing to the waterlogged character of this low-lying area are described in some detail. The casualties suffered by the Belgians at various periods from November, 1914, to September 15th, 1918, are set out; the total loss amounted to 1,220 officers—of whom 319 were killed in action or died of wounds—and 41,793 other ranks—of whom 9,543 were killed in action or died of wounds. The average strength of the Belgian Army during this period was 137,000 all ranks. A table is given showing the length of the front held by the Belgian Army at various dates, and its strength at the same time: on 10.11.14, approximately 11 km. of front were held by 69,000 men (39,000 rifles); by 6.6.16, the Belgian front had been gradually extended to about 32 km., when it was held by 140,000 men (64,000 rifles). The Belgian Army reached its maximum strength, viz., 162,000 men (65,000 rifles) at the beginning of July, 1917; on 7.7.17, the length of front held by this force was about 23 km. The Belgian front was again extended gradually, and on 6.6.18 it stretched from the sea to the Ypres-Zonnebeke road (about 38 km.). A sketch map is provided; on it are marked the positions of the Belgian flanks at certain dates.

The events on the Belgian front during the period November 11th to December 8th, 1914, and the instructions issued to Divisional Commanders on November 18th, 1914, setting out the main lines on which they should organize their defensive arrangements, are also contained in No. 4 of the *Bulletin*.

The events during the period December 9th, 1914, to January 25th, 1915, are dealt with in No. 5. Towards the end of November, 1914, Joffre had decided to take advantage of the withdrawal from the Western Front of German troops, which had been transported to East Prussia in order to take part in the Russian campaign. He now proposed to resume offensive operations. Accordingly, a request was made to the Belgian

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High Command to take over a part of the allied line in Flanders held by the French ; this request was acceded to, and the Belgians, in consequence, extended their front southwards from Dixmude to Knocke Fort (9 km.) during the night of December 8th/9th, 1914. A sketch map is provided, and shows the distribution of the Belgian divisions during the period 9.12.14 to 25.1.15. The operations carried out in the neighbourhood of Nieuport by French troops during the latter half of December, 1914, and the part played by the Belgians to divert the enemy's attention, are briefly touched upon.

The events during the period January 26th to March 10th, 1915, are dealt with in No. 6 ; between these dates, the activity on the Belgian front was confined generally to bombardments, and a few actions of minor importance involving enterprises, usually unsuccessful, undertaken by the Germans against the Belgian advanced posts. At one point in the Nieuport sector, however, the enemy succeeded, after a violent bombardment, in driving small detachments of the Belgian 4th Division from their trenches ; a counter-attack for the purpose of regaining possession of them failed, and, in consequence, a new position—300 m. further back—was taken up. Towards the end of January, 1915, the Belgian High Command was requested to take over a further section of the front held by the French ; the texts of a note (dated January 21st) sent to the French Mission agreeing to the proposal, and the orders issued on January 24th to the Belgian Divisional Commanders in relation to this matter are reproduced.

During the winter of 1914–1915, the inundations along the Belgian front caused, at times, considerable inconvenience ; the measures adopted to cope with the situation are briefly described in No. 6.

Les armées dans les Alpes occidentales. The final part of the article on this subject, by Major Delvaux, is published in No. 4 of the *Bulletin*. In it are discussed, *inter alia*, matters connected with the time taken in moving armies over considerable distances ; the military use of railways ; the intervention of Napoleon III in Sardinia's cause ; the railroads of the French Alps ; the military uses of motor transport ; the assistance rendered to Italy by her Allies during the Great War ; and the frontier zone of the Alps.

Major Delvaux points out that the utilization of steam-engines and other forms of self-propelled vehicles has brought about a great revolution in the technique of transport ; both the tonnage of a military convoy and also the speed of its movements have been, for instance, enormously increased. To-day, the solution of strategical problems is more than ever dominated by considerations affecting supply magazines and munition dumps. Hence, we find that large armies are almost rigidly tied to the railroads in the theatre of operations.

Major Delvaux touches upon the American " Dispatching System," which was adopted during the Great War on the French and Belgian railways, and gives an estimate of the economies claimed to be effected thereby.

An outline is given of the measures adopted in 1859 in connection with the transport of the French Army of 140,000 men collected by Napoleon III at Paris, Nancy, Lyons and on the foothills of the Alps for the Italian campaign. The traffic capacity of the roads and railways leading from

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France into Italy was found to be insufficient to meet all the requirements of this force, and, in consequence, a part of it had to be conveyed by shipping to Genoa. The steps taken to meet the supply requirements of this force during the campaign are touched upon.

Details are given of the motor routes and railroads which existed in the Western Alps in 1917, and the uses to which they were put in September and October, 1917, when a reinforcement of heavy artillery (with its ammunition) and an allied force of 150,000 men were sent to the Italian front for the purpose of repairing the situation created by the Caporetto disaster. Stress is laid on the fact that whereas in 1859, after being conveyed by rail to the lower slopes of the Alps, the French troops under Napoleon III had to march through the mountain passes on foot, on the other hand, during 1914–1918 the allied infantry was carried to its destination by rail and motor vehicles, and the artillery and cavalry alone made the passage of the Alps by road.

Tannenberg. D'après les ouvrages officiels allemands. The final part of the article by Captain Vandaele is published in No. 4. It deals with the last phase of the Battle of Tannenberg (August 30th and 31st). The Russian North-West Army was superior in numbers to the German Army in East Prussia. Samsonof's force was composed of five corps, a fusilier brigade, and five cavalry divisions; the Germans were in a position to bring into the field only three active corps (two of which had already suffered heavy casualties in the fighting near Gumbinnen and Stallupönen), a reserve corps and a reserve division. The remaining troops under von Hindenburg consisted of Landwehr and Ersatz formations, which were not properly equipped for the purpose of taking part in a war of movement. The opposing forces were constituted as follows:—

	Germans.	*Russians.*
Infantry:	153 bns. ... 144,000	175 bns. 175,000
Cavalry:	58 sqdns. ... 9,000	99 sqdns. 16,000
	153,000	191,000
Machine-guns	296	384
Field-guns	728	612

It is claimed that, in these circumstances, the victory of Tannenberg must be attributed to the superiority of the German generalship; it constitutes a record, being the biggest successful encircling movement known to history since the days of Leipzig, Metz and Sedan. Not only was the German attack delivered against a superior force, but at the time both flanks of von Hindenburg's army were also threatened by superior Russian forces. Military history affords no second example of a success obtained in similar circumstances.

Quelques aspects de la campagne des auto-canons mitrailleuses en Russie. The original article appears in No. 6, and is the reprint of a lecture given at Antwerp in February, 1929, by Major-General Semet, of the Belgian Army, who describes therein his experiences whilst serving with the Belgian Expeditionary Corps in Russia during 1916 and 1917.

Remorque-citerne pour char léger Renault. The original article is contributed to No. 6 of the *Bulletin* by Lieutenant de Grave; it contains a description, with illustrations, of a trailer to accompany tanks. The vehicle has been designed to meet the requirements of the *Section Tech-*

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nique des Chars d'assaut of the French War Ministry; successful experiments with this type of trailer manufactured by the *Societé anonyme des Usines Renault* were carried out by the French Army during the Morocco Campaign in 1925.

W.A.J.O'M.

REVUE MILITAIRE SUISSE.

(1929. NOS. 1 TO 6 INCLUSIVE.)

L'évolution probable de la guerre. This article is contributed to No. 1 of the *Revue* by Colonel Lecomte; it deals with a theory advanced by Emile Mayer in the last chapter of his book, *Trois maréchaux: Joffre, Galliéni, Foch* (pub. in Dec., 1928, by the Librairie Gallimard, rue de Grenelle, Paris). Mayer has the reputation of being a prophet; many years before 1914 he foretold, in the pages of the *Revue*, that in a war on a large scale on the European continent there would be a stabilization of battle-fronts. He now predicts that land forces will, in the near future, *almost* completely disappear, and the duties of such units as may continue to be retained will then be concerned alone with the maintenance of order and with colonial enterprises. He thinks that "in fact, the orthodox principles of strategy and tactics will cease to have a *raison d'être*. The military art will also disappear. Posterity will no longer have a need for generals of the type of Joffre, Galliéni and Foch."

Colonel Lecomte suggests that if Mayer's latest prophecy should prove to be a correct prediction, then all the civilized powers are at the moment astray in relation to the military policies being pursued by them: France, in her new law relating to national defence, is aiming at the introduction of a military organization which will embrace the whole of her population, men and women; Switzerland is wedded to a mild form of conscription for the purpose of maintaining a land force of the old type; even the League of Nations recognizes that a military force of the Swiss type is a necessity for every self-respecting nation.

Mayer's prediction is based, needless to say, on the assumption that, in the future, the hostile activities of belligerent nations will largely, if not exclusively, take the form of aero-chemical warfare. Colonel Lecomte has made a careful and interesting examination of this question in his article. He admits, of course, that a very considerable development of aero-chemical warfare is inevitable in a future campaign, but he is far from agreeing entirely with Mayer's conclusions. He accepts the view that aviation has reduced the value of cavalry, and also, at least, of heavy artillery, but he points out that, on the other hand, the engineering arm retains all its former importance, and, indeed, he suggests that the more industries progress, the more pressing will be the demand for technical troops, and, at the same time, much more important and varied will necessarily be the duties which they will be called upon to undertake.

Les armes d'accompagnement de l'infanterie. The original article is published in Nos. 1 to 4 inclusive of the *Revue*; it is a translation of a contribution by Captain Däniker to Nos. 9 and 10 (issues for Sept. and Oct., 1928) of the *Allgemeine Schweizerische Militärzeitung*. The evolution of the supplementary weapons of the infantry and the tactical requirements giving rise to their introduction are dealt with in No. 1 of the *Revue*. It was in Germany, Captain Däniker points out, that an

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attempt was first made to make practical use of the lessons to be learnt from the Russo-Japanese War; in 1905, a *Minenwerfer* was constructed and handed over to the Pioneers of the German Army for trial. Later, lighter types of this weapon were introduced into the Kaiser's Army; the weapon was intended originally for the purposes of fortress warfare. However, in the early days of the Great War when the battle-fronts became stabilized in the Western Theatre, the importance of this type of weapon as a supplementary armament for the infantry in the field warfare became evident, and it was accordingly issued to it; at the same time, steps were taken to increase the mobility of this weapon. The successive developments which took place during the progress of the Great War in the armament of the infantry of the belligerent armies is traced by Captain Däniker.

Tactical requirements are discussed at some length by Captain Däniker, and his conclusions are then summarized. It is pointed out that the chief *desiderata* in the supplementary infantry armament are simplicity in design; ease of manipulation; facility of maintenance in good order; and robustness, *i.e.*, capability of continuous use without jamming, etc., so as to inspire the utmost confidence in those who have to handle such weapons in action. Captain Däniker recognizes that the number of types of weapon comprising the supplementary armament of the infantry should be as small as possible; the same weapon should be capable of effective use both against hostile tanks as well as aeroplanes when flying low.

The technical considerations affecting the supplementary infantry armament are very fully discussed in Nos. 2, 3 and 4 of the *Revue*. Particulars relating to various types of infantry weapons which have been brought into use, and the requirements of the Swiss Army, are also dealt with in No. 4 of the *Revue*.

La neutralité belge et le plan de campagne allemand. The original article is contributed to No. 2 of the *Revue* by Colonel Lecomte, who deals with the plan of campaign on which the opening phases of the Great War; he calls attention to the views in relation thereto contained in Dr. Bredt's recent work: *Die belgische Neutralität und der Schlieffensche Feldzugsplan* (pub. by Georg Stilke, Berlin, 1929: 10 mk.). Incidentally, Colonel Lecomte mentions that Dr. Bredt has treated the subject with great impartiality, and has avoided special pleading. The question which occupies the greatest prominence is whether the Great General Staff was right in its conclusion that, in a war on two fronts conducted simultaneously, only one plan of campaign could rightly have been considered as affording a promise of success, namely, an offensive, in the first instance, directed against France, involving an invasion of Belgium, coupled with a defensive attitude on the Eastern Front. Colonel Lecomte suggests that up to 1892 the plan outlined was not the one most generally advocated in Germany; in support of his contention, he cites the German plan of campaign prepared in 1891, which is discussed by Reginald Kann in his work, *Le plan de campagne allemand de 1914 et son exécution* (pub. by Payot, Paris, 1923, 10 fcs.). In the sketch plan showing the dispositions of the German forces for the execution of the 1891 plan, three armies are shown attacking at the Gap of Charmes, whilst three others are "slipping" along the Belgian frontier for the

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purpose of crossing the Meuse just N. of Verdun. The plan put in force in 1914 appears to date from 1905. In the year last mentioned, von Schlieffen carried out a War Game based on the supposition of a war in which the two Central Powers, Germany and Austria, were opposed by a coalition consisting of France, Russia, England, Italy, Rumania and Serbia! It was then that the new doctrine took shape: "defeat the most dangerous enemy, *no matter how*, before the others are ready."

The much discussed question whether Germany's failure to win the War was due to the modifications in von Schlieffen's plan made by von Moltke, the younger, is examined by Colonel Lecomte: his opinion is that the modifications made by von Moltke were not responsible primarily for the German failure, which, he suggests, was due really to the erroneous view taken of the situation as a whole by the Great General Staff. Colonel Lecomte's appreciation of the situation can be summarized as follows: in any case, the major part of the Austro-Hungarian Armies would necessarily have to operate on the Eastern Front; if the Germans, therefore, had decided to support them vigorously on the outbreak of the War, the chances are that the Russians would have been completely beaten in sufficient time to allow the Central Powers to throw their full weight successfully against the Anglo-French Armies on the Western Front. Accordingly, the invasion of Belgium was not only a moral wrong and political blunder, but at the same time a military error of considerable magnitude.

La guerre aéro-chimique et la défense anti-aérienne. The original article, two parts of which are published in Nos. 2 and 5 of the *Revue*, is contributed by M. S. de Stackelberg, an Engineer. A reference is made in No. 2 to the aero-chemical experiments carried out by the American Chemical Warfare Service at the Aberdeen Proving Ground (U.S.A.). Questions relating to the employment of aircraft for bombing and chemical warfare purposes are discussed in the first part of the article, and the considerations affecting anti-aircraft mobile and fixed defences are also examined therein.

A description, with illustrations, of the new Varaud clockwork fuse is given in No. 5, in which the technical considerations relating to anti-aircraft defence weapons are also dealt with.

Un précurseur, le Colonel Julius Meyer. This article appears in No. 6, and is contributed by Colonel Lecomte, who deals with problems of former times and of to-day, relating to frontier defence. Attention is called to the mobile cupola designed by Colonel Schumann, of the Prussian Engineers, and constructed in 1886 by the Gruson Firm, at Buckau, and to the theories relating to the use of the same advanced, some 40 years ago, by Julius Meyer, of the Swiss Army, whose ideas were in advance of his times. The adoption of tanks in the Great War meant the realization, Colonel Lecomte points out, of Meyer's prophetic vision, and it is a matter of considerable interest, now that France has taken steps to fortify her new frontier, and particularly the region of Metz, to learn that Meyer's ideas are to be incorporated in the scheme of frontier defence which has been adopted by the French War Ministry.

W.A.J.O'M.

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THE BUILDER.

The Builder of June 21st mentions a way of treating a concrete floor to prevent the formation of dust from hard use. Silicate of soda or water glass (or magnesium silico-fluoride, which is better, though more expensive) should be applied as a wash, so as to form a hard silicate of lime (converted into fluorspar in the second case) in the top layer of the floor.

The method employed is to scrub and cleanse the surface thoroughly with several changes of clean water and to allow it to dry out completely before each operation. The solution should be made fresh immediately before use, by dissolving one gallon of commercial silicate of soda in four gallons of water ; the resulting five gallons should not be stretched over more than 1,000 fs. of surface for each coat. Apply the solution with a mop or hair brush over the whole floor in one continuous operation, and brush in well, without stopping, for several minutes to obtain an even penetration. At least 24 hours in dry weather to several days should be allowed for the surface to dry and harden, after which it is scrubbed again with clean water and allowed to dry for the next operation. Three such coats in this manner will produce a very hard surface of uniform appearance.

The softness in a concrete floor may be caused by an excess of cement or overtrowelling of the surface ; it is not sufficiently appreciated that the true wearing surface of a concrete floor consists of the portions of the exposed aggregate, and that, for this reason, the aggregate must be itself hard as well as properly proportioned and graded, so that it may form almost the entire area of the surface.

———— D.M.F.H.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1929.)—The fifth instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division*" describes the situation after the first rush of the division was over, and before a further advance could be made. The German resistance had begun to stiffen, the barrage was lost by the infantry, and by ten o'clock the whole division had come to a halt. There is little of special interest in this instalment.

"*Après la conférence de Rabat*," by Général Meynier, is a most interesting article on the inter-colonial conferences, now held annually in Northern Africa, and their results. In 1923, M. Millérand made a journey through Northern Africa, and was surprised to find that each colony was separated from the other as if by water-tight compartments. He instituted, therefore, these conferences, and they have been held at Algiers, Rabat (in Morocco), and Tunis. Since 1924, there has been only an interval of one year without a conference, due to the Rif fighting. The writer points out that the time for a governor over the whole of French Northern Africa is not with us yet, but he makes it quite clear how the country has advanced since the conferences started. The most striking development has been the marking out of tracks across the Sahara, combined with an excellent system of wireless telegraphy ; and naturally the pacification of the country has progressed accordingly. Northern Africa is now recognized as part of France for defence, and naturally its development adds greatly to the forces which can be produced, should France go to war again.

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"*Rôle et instruction des interprètes*," by Colonel Paquet, is an important article on the training of intelligence personnel for war. He points out that the intelligence officer must understand the staff system, and realize what is the general situation, before he is fit to ask questions as an interpreter. Colonel Paquet, therefore, recommends that a school be formed for the instruction of reserve intelligence officers, the final aim being that the second (or intelligence) bureau will eventually be largely staffed by interpreters. An advance has already been made by an increase in the lectures which interpreters of the reserve must attend; but, as Colonel Paquet points out, more is required for all interpreters to achieve the necessary standard.

"*La structure générale des campagnes offensives de Napoléon*," by Général Lemoine, is yet another discussion of the Emperor's methods. It is pointed out how he would begin a war on a wide front, contract for battle, and open out again in pursuit. The object of the article is to show how we can still learn from the study of Napoleon's campaigns, in spite of the development of material and man-power since his day.

(*May*, 1929.)—The sixth instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division*," describes the capture of Mezières and the Bois du Dé, followed by a temporary calm over the whole battlefield just after mid-day. The calm was due to the disorganization of the enemy and the movement forward of the French guns.

"*Le problème abyssin*," by Commandant Cornet, describes the present situation in Abyssinia. After considering the country, climate and people, the writer goes on to study the rivalry between France, Italy and Great Britain. The Abyssinian empire, being the sole native survivor of the different states of Africa, is naturally unwilling to give way to the pressure of either of the three European countries, and Commandant Cornet explains clearly how far they have been successful.

In "*Les services de la Xe armée pendant les offensives de 1916 sur la Somme*," Général Thévenet describes the L. of C. organization used during the great battle. The article is not particularly interesting, but it does show the enormous back organization required to set in motion a force (720,000 men in the army) during trench operations.

Capitaine Marchal begins an interesting article entitled "*La VIIe Armée Allemande en Couverture en août 1914*," in this number. This Army, under command of General von Heeringen (whose previous career is clearly sketched), had two tasks :—

(*a*) To cover the German concentration by holding Upper Alsace. Any combined hostile attacks were to be met by a withdrawal across the Rhine.

(*b*) The protection of the Grand-Duchy of Baden after the move of the 6th Army (on the right) into Lower Alsace.

In opposition was Dubail's 1st French Army. He had received orders to advance into Alsace, and the first movement was carried out by the 7th French Corps. In this instalment the writer describes the Corps advancing to a position ready to descend into the lower country of Alsace on 7th August.

"*Trois conférences à l'Etat-major de l'armée en 1902*," by Général Palat, describes three lectures given after the South African War. One was by Captain Fournier, who finally commanded the 8th Corps in the

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Great War, the other two by Lieutenant-Colonel Berrot, of the 3rd Bureau (Operations). Although sensible lessons were drawn from the British mistakes in South Africa, it was not realized in these lectures that artillery would not always be far less dangerous than small arms. In South Africa the percentage of small arms casualties was far greater than that due to artillery fire ; but we know well now that this by no means held good during the Great War. What was clearly brought out from the lectures, however, was that the form of war to be employed must depend on the training of the soldier and the armament available.

(*June*, 1929.)— The seventh instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division*," brings us up to the preparations for an attack on Fresnoy, towards the evening of August 8th. The advance of the division, laid down beforehand, had definitely come to an end ; but orders were received to push on in spite of the fatigue of the troops. These instalments give so much detail over such short periods, that they are really only of interest to those who actually took part in the battle.

"*La défense antiaérienne des grandes unités*" is an important article by Lieutenant-Colonel Vauthier. He discusses first the methods adopted by other countries, and then turns to what is required in France. It is pointed out that anti-aircraft artillery will either consist of special weapons for this type of work or of ground weapons used for fire in the air. Lieutenant-Colonel Vauthier considers that both types may be employed with advantage in the French Army. This instalment concludes with a specification of what would actually be required in a division and in a Corps.

In the second instalment of Capitaine Marchal's "*La VIIe armée Allemande en converture en août* 1914," the preparations for the German counter-attack are described. A sketch map indicates the concentration of the German forces and General von Heeringen's orders are given. His final plan was to crush the French left, but, in spite of a considerable German superiority of force, the attack was too late to effect this plan. The instalment closes with the German 14th and 15th Corps just coming into action.

Général Armengaud begins "*La pacification de l'Afrique encore insoumise*" in this number. As he points out, there are three stages to be completed, penetration, occupation and policing of the area. He then shows that General Lyantey's maxim, "With the natives one must always show strength, so as not to have to use it," is more than ever true in these uncivilized countries. The modern method of action is first to combine political methods with the threat of air action. If this is not successful, air action follows, supported by the threat of ground action, which can be brought into force when required. After the penetration has been successful, occupation and policing can be carried out, largely by air action. The writer contrasts the French advance in Northern Africa with the British operations by air since the Great War, in Iraq and on the N.W. Frontier of India ; and he makes it quite clear that air forces, provided that they can be supported on the ground, reduce enormously the casualties and difficulties previously experienced in these countries.

"*La Genèse de Neufchâteau*," by Commandant Pugens, describes the

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events leading up to the battle of Neufchâteau, where the French were nearly successful in inflicting a serious check on the German 4th Army. This army was commanded by Duke Albrecht von Würtemberg, probably the most efficient of the German royalties who commanded armies at the outbreak of war. The Army had a difficult task from the start, as it had to be in a position either to turn south to support the 5th Army on its left, or to intervene in the more important operations of the 3rd Army on its right. In this instalment the writer deals with the preliminary orders issued by von Moltke, and the early moves of the 4th Army. H.A.J.P.

HEERESTECHNIK.

(*October.*)—*Motorization Questions in Foreign Armies, the Belgian Artillery.* Compiled from an article by Major-General Pierret in the *Bulletin Belge des Sciences Militaires*, from which it appears that the Belgians are inclined to be conservative in this matter. One is prepared for this attitude by an early statement of Belgian conditions, viz., that the rise in the price of petrol, high taxes, and expensive repairs requiring specially skilled workmen, have in many places lately brought about an increase in the amount of horse-traction: that in agriculture the mechanical tractor is now less used: that the total number of horses in Belgium has so much increased lately that the number exported annually is greater than before the War.

The author's answers for Belgium are: for infantry guns, cross-country tractors: for divisional artillery, horses: for artillery with cavalry divisions, horses, or, if howitzers are introduced, cross-country tractors: for corps and army artillery, tractors: for anti-tank guns and anti-aircraft guns, self-propelled carriages: reserve artillery to be carried on lorries.

The Great German Wireless Exhibition, 1928. The chief object of interest this year was something connected with wireless, but not essentially wireless in nature, viz., electrical vision. Two methods of electrical vision, those of Mihaly and of Karolus, were shown, the one among and the other next to the historic and instructive exhibits of the national Post-office.

For electrical vision, as for picture-telegraphy, which has already taken its place alongside music and speech, as a thing broadcast for entertainment purposes, the essentials are that the object to be shown at a distance by electrical means must be capable of being broken up into minute areas, that these areas must be capable of being touched off in rotation, that their differences in shade be electrically transmitted (by wires or wireless), be re-converted at the distant station into light differences, and the corresponding picture re-assembled.

For picture-telegraphy, since the areas are touched off in rotation, only one channel of communication, wire or wireless, is necessary. For electrical vision to be truly simultaneous, as many channels of communication would be necessary as the enormous number of small squares into which the picture is broken up. This, of course, is out of the question; but fortunately it does not matter. Since the inertia of the human eye causes it to receive as simultaneous images occurring as much as ·1 second apart, the simultaneous touching off of all the small picture-

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elements, and their simultaneous re-assembly, are unnecessary. The elements need only to be touched off in sufficiently rapid succession. Thus, a picture 1 decimetre square (say 4 in. x 4 in.) contains 10,000 squares of 1 mm. side ; ·1 sec. only is available for all parts of the picture to appear simultaneous ; therefore picture-elements must be dealt with both at sender and receiver at the rate of 100,000 per second.

Both systems shown at the Exhibition are capable of this speed. Mihaly uses at both ends a disc with holes in it arranged along a spiral. Considering, then, any rectangle past which the disc rotates, light shining through the holes in the disc will fall upon that rectangle in a series of parallel curves. In one rotation of the disc as many lines of light will traverse the rectangle as there are holes in the disc, each line being 1 mm. further from the centre than the preceding one.

Mihaly's cycle is : source of light, lens, transparent picture, rotating disc with holes, light-cell, current-conductor, glow-lamp, lens, rotating disc with holes, screen. Perfect synchronization and the perfect sensitiveness of the glow-lamp are the chief features of this system.

Karolus also uses the light-cell method, *i.e.*, the touching off is done by a light-ray, and not by the metal pencil of the telautographic method (*v. R.E. Journal*, Sept., 1926). Karolus' method differs chiefly in that the source of light at the reception-end is not current-controlled ; but a steady light falls upon a Kerr-cell. The principle upon which this cell is built is the Kerr-effect, by which changes in the double refraction phenomenon of certain liquids, like nitro-benzene, follow without inertia changes in the incoming current.

With all due appreciation of what has been achieved, it must be admitted that electrical vision is still deep in the laboratory stages, and a long way short of practical use.

This stricture applies to electrical vision of people and scenes, and not to that of cinema films, which are specially suitable for the purpose, inasmuch that they lend themselves to the use of very bright beams of light passing through photographs prepared with very sharp contrasts. America can already show some success in this direction.

As regards the military uses of electrical vision, the Americans have already foretold the day when the battery-commander will watch the effect of his guns as seen from an aeroplane over the target and transmitted to him on the ground at the battery. The utility of such an arrangement is unquestioned, but it almost appears as if these prophets had overlooked amongst other things the extreme degree of fineness of the image seen in a telescope or field-glasses. In order to deal with such, the elements would have to be of the order of ·01 sq. mm., a minuteness which in the present stage it is impossible even to foresee.

The public was also much interested in picture-telegraphy. Whereas last year's exhibit of the Telefunken-Karolus system was confined to sending pictures over land-lines, the development was clear this year to wireless picture-broadcasting. Various systems were shown. The Telefunken Company, with light-ray at sender and electro-chemical reception, sent pictures 13 x 18 cm. (say, crown octavo size) in about 1 minute ; hence to be capable of becoming visible to the eye as an instantaneous image, instead of being reproduced as a permanency, the picture would have to be touched off 600 times as fast.

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A Fultograph, the invention of Capt. Fulton, and used for broadcasting pictures from the Vienna station as part of their programme twice daily, was also shown. This is a telautograph, using electro-chemical means at both ends.

Professor Korn's apparatus, as used by the German police, was also shown. It has photo-electric touching off, with photographic reception worked by the ribbon galvanometer (*R.E. Journal*, September, 1926).

The Ministry of Transport (Air Department) showed ground and aeroplane instruments for direction-finding. There is again this year a noticeable decline in the number of types of receivers shown, with a corresponding improvement in quality. For long range reception, neutrodyne and superheterodyne receivers were in abundance. With apparatus for connecting to light-mains the broadcasting short-range receiver has become as simple as the electric-iron, and is becoming increasingly popular.

The electro-magnetic cone loud-speaker holds the field against the electro-static and electro-dynamic, although the superiority of these latter is certain.

To the number of types of valve shown, which is already excessive, must be added Telefunken's exhibit of the Tetrode, which by adding as fourth electrode a grid-screen, eliminates grid to anode capacity. Finally, as regards a matter which is only related to wireless technics, the " Talkies," there is no question that the possibility now exists of combining the ordinary cinema film with speech. A high pitch of excellence was reached by the talking film, " Triergon," at this Exhibition. It is, however, not yet certain whether it is desirable to convert our silent films to talking films, and perhaps the most obvious use of this invention would be for giving people, acoustically as well as pictorially, the news of the week.

The latest Anti-tank Weapons. The latest development of tanks in the contest between mobility and armour is towards the former, hence less weight and less demands on bridges. Tanks under 12 tons are preferred and these would have 20–25 mm. of armour. Even with tanks twice the weight mentioned, armour would not be thicker than 30 mm.; while armoured cars carry only up to 12 mm. of protection.

Defensive weapons have followed this development. The lower limit is the 13 mm. (·5 in.) machine-gun, intended in the first place as an anti-aircraft weapon, but capable of being used against armoured-cars.

As regards anti-tank weapons the chief requirements are good shooting (dependent upon high muzzle-velocity and the utmost handiness in traversing), penetrating power and sufficient explosive effect after penetration to put the tank out of action. The requisite power of penetration is gained with not less than 3·7 cm. (1·5 in.) calibre; but there is also an upper limit. A diagram shows how the smaller calibres with their higher velocities are superior to the larger calibres in penetration, and that the upper limit lies at 5 cm.

The limit of weight beyond which an anti-tank weapon ceases to be sufficiently mobile may be taken as 300 kilos (say 6 cwt.).

The question whether infantry-guns should take over the task of anti-tank defence must be answered in the negative. The matter was tried out thoroughly by the United States in 1920, when a compromise between

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the conflicting requirements was found to be impossible. As a result of this decision the U.S.A. have produced two weapons, the 37 mm. infantry-gun and the 75 mm. infantry-mortar.

For mobility, wheels must be as large as possible, consistent with not offering too great a target. A shield is necessary against the fire of the tank's machine-guns.

Other points which are occasionally demanded must not be considered less important, especially the breaking up into separate loads reduces the degree of readiness of coming into action, and involves the danger that an essential part may be missing when required.

As long as the limit of weight of 300 kilos is kept, the limit of penetration is 25 to 40 mm. Hence, heavy tanks armoured up to 30–40 mm. in front can only be penetrated at the shortest range. They must, therefore, either be fired at from the side or from behind, or left to the larger field-guns farther back to deal with.

A tabulated list is then given of the particulars which are available of 21 modern machine-guns of the leading nations in three classes :—

(A) 13 mm. Class, chief task, anti-aircraft.
(B) 20 mm. Class, chief task, anti-tank and anti-aircraft.
(C) 3·7 to 5 cm. Class, chief task, anti-tank.

Unfortunately, with the exception of two American weapons, the list is confined to machine-guns of private construction : also it has not been possible to produce a table to show comparative penetrations. Photographs are given of the 12·7 mm. Beardmore-Farquhar, of the 13·2 mm. Hotchkiss on light field carriage, and of the Dutch m.g. of the Holl. Ind. en H. Matsch.—(*To be continued.*)

Modern Road-making Methods and their Applicability to Military Purposes (*concluded*). The author continues his description of modern methods of road-repair—surface-dressing, carpeting and tar-macadam. As regards new roads he laments that, although concrete-roads had a start in Germany of nineteen years (1891) against tar-roads (1910), in spite of the enormously increased use of concrete in all sorts of building, and in spite of much experience on the subject gained abroad, concrete roads in Germany are still in the nursery stage. While in the U.S.A. 60,000 km. of concrete roads had been built up to the end of 1925, the total length of such in Germany up to date is only 70 km. The reasons for this backwardness, he says, lie in no doubt as to the suitability of this material for road-construction, but in the facts that before the War lorry-traffic had not reached such dimensions as to cause undue wear upon the roads, that during and since the War Germany has had more serious cares to attend to, and is still too poor to undertake new road construction on a large scale.

For such construction concrete, as forming an excellent material, would be considered in the first place. The chief military considerations Lt.-Colonel Wabnitz defines as follows :— " Simplicity, rapidity, as little transport as possible, ease in handling the materials, and small amount of labour required." There should surely be in this list a place for the earliest possible resumption of full traffic on the road under repair. Summing up :—

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1. Surface tarring is a suitable method of protecting metalled roads, which are still in a good state of repair, against the destructive effect of heavy lorry traffic.

2. Tar concrete carpeting offers a simple means of preserving from further decay roads which are worn, by means of a resisting covering. The Cold Process is to be preferred on account of its independence of the weather.

3. For new roads to be quickly made, concrete comes first of all (record performance, 800 running metres, 5·5 metres broad, in 13 hours!) Next, tarred metal laid cold (*e.g.*, Tarmac process); and last (Deidesheimer), large metal with fine metal binding and saturated with tar-emulsion (Kiton or Magnon) before final rolling.

Automatic Ciphering, by Lt.-General Schwarte. The elimination of the human element in enciphering and deciphering is a matter of great interest to the General Staff and to all connected with operations. Their clamour has always been for a cipher-machine to relieve them of what the author, doubtless speaking from experience, calls "one of the most tedious and unpleasant tasks."

In last month's description of the Press Exhibition at Cologne, Lt.-Colonel Pleger calls attention to the "Cryha" Automatic Cipher-machine and this instrument is now described by Lt.-General Schwarte.

The principle upon which it works is that of the well-known figure cipher (*v.* Jules Verne). Before Playfair was invented, the simplest way of avoiding mere substitution was to substitute according to numerical plan. A key number was chosen of, say, five figures, and repeatedly applied to the letters composing the message, showing how far in the alphabet each letter was to be carried forward to obtain its cipher equivalent.

Once the "Cryha" is set, each letter is enciphered by being carried forward a certain number of places, determined by the position of a wheel with 15 holes and 15 different sets of projections on the periphery corresponding to those holes. This gives a key number of 15 figures, so makes discovery enormously more difficult than it would be with the normal five figures. At the same time the alphabets used are jumbled alphabets.

The "Cryha" would thus appear to guarantee absolute secrecy. As, however, the almost uncanny skill of cipher-experts is known, and as the "Cryha," although sold by Marconi's, is manufactured entirely in Germany, it would be wise for anyone, who wants to defeat all attempts at discovery, to do some judicious file-work on the periphery projections of the two sets used, in order to make sure that no other similar machines are in existence to assist in betraying one's secrets to the enemy's Intelligence Branch.

Mediæval Artillery, by F. Sonnenberg. A clever and amusing review of "*Das Geschütz im Mittelalter*," by Bernhard Ratgen, in which the reviewer starts by addressing the patron-saint of all artillerymen, Saint Barbara, and complaining that, after all his efforts in keeping himself abreast of the developments of her black art, she now turns back the hands of the world-clock half a century and orders him to deal with artillery as it then was.

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The book itself, which took an artillery officer 25 years of research to write, is praised with such phrases as " with increasing astonishment one perceives that one is falling more and more under the ban of this book," " its great instructional value lies in its putting Why in the foreground and not How," " thrilling from end to end."

The new Explosive, " Radium Atomite." On the authority of " Army Ordnance " some wonderful things are claimed for this new substance—that it contains neither nitroglycerine nor guncotton ; that its detonation-velocity is 3,270 metres per second ; velocity can be regulated, so that radium atomite has been used in the Springfield rifle ; explosive-effect compared with TNT 100 : 60, compared with Blasting Gelatine 100 : 78·5 ; catches fire at 148° C. ; does not freeze ; no poisonous gases on detonation, except 21 % Carbon Monoxide (!) ; no headaches caused when used in mines ; can be prepared from raw material in eight hours ; no danger in manufacture ; neither detonated by friction nor by a blow. When it is further stated that the inventor has produced this explosive " after being occupied with radium for 25 years (!) " scepticism is fairly thrust upon one.

(*November.*)—*The latest Anti-tank Weapons* (*concluded*). The following are described, with photographs : In the B Class, the Danish 20-mm. Madsen m.g., which is only a larger edition of the well-known Madsen light machine-gun. In the C Class, the 3·7-cm. Bofors Infantry-gun, the United States Infantry-gun M1 of the same calibre, the 4-cm. Beardmore (with mention of a new infantry-gun by the same firm of 4·7-cm. calibre), the Polish 4·7-cm. Pocisk, and the heaviest of the three, the 4·7-cm. Bofors, with splayed carriage, which pierces 40 mm. of good armour at 900 metres.

The m.gs. in the C Class are then compared as far as data are available, and criticized. Their future development is foretold in an increase of muzzle-velocity and in an increase in the width of aiming arc, which is at present 40° at the outside.

The Qualities of a Good Vehicle, by Major Gieseke. The author takes the three different types of horsed vehicle found in the German Army, viz., the wagon with perch, the wagon with limber-bolt and the limbered wagon, and considers each of them in turn as regards the three qualities, flexibility or the ability to follow a tortuous course and to adapt itself to surface-irregularities, stability and axle-freedom. The wagon with perch was long in disfavour with military wagon constructors because of its relatively low flexibility, and it was looked upon as too stiff for uneven country. Strong emphasis being laid upon increased flexibility, with universal wheels, led to the limber-bolt system, which had the further advantage that the load was carried not on four points, but on three ; hence greater stability, the load being taken off the front axle. During the War, the Austrian Army had quite another experience of the wagon with perch, and German reports on it were also not unfavourable. The wagon with perch has thus come to be looked upon with a more friendly eye. If loosely fitted together, it gets over rough ground just as well as the wagon with limber-bolt : and has the great advantage of being much cheaper, both in provision and maintenance.

The limber system, by reason of the limber-hook and eye, has the greatest flexibility and axle-freedom, but on account of its small loading

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space, complicated construction and great cost, it must be confined to those special cases of wagons which have to traverse rough ground at all costs, viz., artillery and trench-mortars. For ordinary transport both the other systems are suitable.

The International Aircraft Exhibition, Berlin, 1928. This was the second exhibition of its kind to be held in Germany, the first having taken place at Frankfort in 1909. There was, however, a National Aircraft Exhibition in Berlin in 1912. It is not possible to avoid comparing this show with the Paris Aero-Salon which is held nearly every year, but is hardly more than nominally international, whereas in the Berlin Exhibition of last year foreign countries were well represented, especially Great Britain, France, Italy, Czecho-Slovakia, Belgium and Russia. The United States were unfortunately only represented by pictures. Another great point is that at the Paris Aero-Salon the military 'planes dominate the yearly show, while in Germany, where military aviation is forbidden, the exhibition takes on an entirely new character, viz., one of civil aviation in all countries.

As regards aircraft lighter than air, the exhibition has little to offer.

The report is under three heads: (*a*) Machines, (*b*) engines and (*c*) accessories.

(*a*) The machines at the exhibition can be classified as traffic and sporting aeroplanes. Training and sporting 'planes can nowadays be hardly distinguished, since almost all instructional machines can be made to serve sporting purposes. A good distinction can, however, be made between ordinary sporting 'planes of at least 80 H.P. and light aeroplanes. Traffic machines can be classed as those with a single engine, with more than one engine, as well as into aeroplanes and hydroplanes.

Light aeroplanes, *i.e.*, those of from 20 to 70 H.P., were strongly represented. They fall into two very different types, the British type of braced biplane (*e.g.*, de Havilland Moth and Avro-Avian) and the aerodynamically superior type of German, Russian, and Czecho-Slovakian monoplanes. If the Klemm-Daimler with 40 H.P. Salmon-engine can put up the same performance as the well-known de Havilland Moth with its 60–80 H.P., there is still a great deal to be said, from the standpoint of the private owner, for the English style of construction, with " simple and cheap " as its underlying principle. Thus, the comparatively robust and primitively-built English light aeroplanes are thoroughly suitable for the hard wear and knocking about that they get in instructional work. Any village carpenter and any shoeing-smith can repair English light aeroplanes. When one adds to this that, with the best materials and workmanship, they are not expensive, it is evident that German light 'plane construction will have to struggle hard against foreign competition.

The 80–200 H.P. class was scanty in numbers, and, at that, the 'planes were all of well-approved types: Albatross, Raab-Katzenstein " Swallow " and " Pelican," and the Bavarian Aircraft Works " Flamingo."

A main centre of attraction was the Italian single-seater Macchi M 52, a Schneider Cup winner, a graceful machine with 1,000 H.P. Fiat engine and weighing only 400 kilos empty. The well-thought-out shape of this

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classical racing 'plane evoked universal admiration. The Czech machines show likewise the high technical position of aviation in Czecho-Slovakia.

Short descriptions are then given of many of the more interesting aeroplanes in the Exhibition, amongst which the following are illustrated with photographs :—

The Czech Smolik-S of the Letov Aircraft Works at Prag (for distant reconnaissance and bombing).

The German H.E. 10 High Seas Hydroplane.

The Junkers W 33 " Bremen," which made the first Atlantic flight from East to West.

The Dornier Super-Whale passenger hydroplane, with two engines built above the wing.

The Dornier Delphin II passenger hydroplane, leaving the water.—(*To be continued.*)

Engineer and Soldier, by O. Schwab, reviewed by Major Kaiser. The attractive title of this book is not true to the usual German practice, as regards titles, of leaving nothing to the imagination. It might mean so many things. The dedication, however, clears matters up, " To the German Army, and to Germany's young Engineers, upon whose shoulders the future of our Artillery rests."

The book deals with the war-service of a civil engineer as an artillery officer, and his activities, especially in sound-ranging and the preparation of shooting-tables. Major Kaiser says that Lieut. Schwab's greatest achievement was the most successful method of breaking the " row of pearls of the hostile kite-balloons." He wishes the title " Engineer and Soldier " to be looked upon as the ideal to which every young artillery officer should strive, even though he may often, and not without a certain amount of justification, " prefer riding to reckoning."

(*December.*)—*Seeing from Tanks*, by Capt. Pirner. Although the technical perfecting of the tanks has made great progress, especially in the last few years, it appears that one of the most important problems—that of seeing from the interior—has found no solution. The author then reviews the whole development, and the present technical position of this problem.

1. Direct observation through slits. This method was exclusively used in the War, the slits being generally conical interruptions of the armour, about 5 mm. high and about 120 mm. broad. These slits were the cause of many very unpleasant wounds in the face and eyes. They had also the disadvantage of a very small vertical angle of view, since in order to avoid injury to the head due to the jolting of the tank, it was necessary to keep the head back a certain distance from the wall. The advantage of direct observation through slits stands in no sort of relationship to the disadvantages named. It is because of such observation that tanks have been called " blind and short-sighted."

2. Observation with mechanical aids. To reduce the number of splinters reaching the observer a rotating disc was introduced, provided with radial slits and driven by a motor. This allowed of an increase in the size of the observation-slit in the tank, *i.e.*, of an increase of field,

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but the chief disadvantage of the small angle of sight remained, and further, the brightness or intensity of the picture was considerably diminished. It is this drawback which caused the method to be abandoned.

More valuable was the Stroboscope, which appeared at about the same time in French and in American military literature. This instrument is about 20 in. in diameter, and is fixed on the top of the tank. It consists of an inner fixed cylinder, in the wall of which are eight equally-spaced rectangular windows, giving an all-round view, and covered with non-splintering glass; and an external cylinder, having 30 vertical slits equally spaced around it, fastened to and revolving with the dome, which is electrically driven at 400 r.p.m.

It is easy to show that this great speed of revolution is so small in comparison with the velocity of an incoming bullet as to have no averting effect worth mentioning.

The motor-drive (¼ H.P.) is either direct on the spindle, or indirect by tooth-wheel on the circumference. The former method has the advantage of allowing Stroboscope and motor to be turned back together on a hinge allowing free observation or even egress from the tank.

The Stroboscope has also, below the rotating cylinder, ordinary observation slits, normally blinded, for use in case the motor fails.

3. Observation with optical aids. The simplest instrument for this purpose is the periscope without lenses. The field of sight is, however, quite insufficient, unless one is prepared to use large reflectors with the corresponding drawback of large openings in the tank. These periscopes leave over 20 yards of dead ground immediately surrounding the tank. There is no likelihood of their being generally introduced.

To give periscopes a larger field the eye must be brought artificially close to the outside opening. This is done by replacing the top inclined mirror by a rectangular prism, with a short focal-length object-glass below it. A reversing lens in the middle of the periscope, and a rectangular prism with eyepiece at the bottom, complete the system; or, which is greatly preferable, the lower prism and eyepiece are replaced by a mirror and dull glass, so that the observer can move his head and observe with both eyes.

This periscope has been used by Goerz in making a cylindrical observation tower for tanks with all-round view. Magnification is provided up to 1·5 to counteract the opposite effect, due to the eye being no longer free, but having its view of an object circumscribed by a narrow opening. Distances are thus not over-estimated, and most people think that they are seeing things their natural size. The brightness of the picture depends in general on the size of the openings, and these must be kept small. The picture also suffers by losses in reflection and absorption, so that details are hard to see, and the quick recognition of distant objects is difficult.

It must therefore be stated that the important question of observation from tanks has not yet been solved. The main requirements are:—

1. Horizontal field, 360°: vertical field — 15°, + 100°.
2. Observer to be safe from bullets and splinters.
3. Both eyes to be used for observation, with free movement of head.

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4. Picture to be as clear as possible, *i.e.*, the greatest possible elimination of light-losses.
5. Easy change to unrestricted view for travelling and when not engaged with the enemy.

The International Aircraft Exhibition 1928 (*concluded*). (*b*) Engines. There was very much worth seeing. While the machines themselves were already known to the experts, amongst the engines there were many constructional surprises, even amongst those which had already been tried out in the air. France and Italy were best represented. The absence of the highly-developed American engine industry was to be lamented. The English show was incomplete, thus Beardmore showed none of his interesting engines, while Rolls Royce were content to show a single one. The interesting Bristol Mercury engine could not be shown, owing to prohibition by the British Air Ministry. Likewise missing were the 700 H.P. Armstrong-Siddeley Leopard, the latest Napier engines, and many more. The triumphal progress of the Bristol Jupiter of 400–500 H.P. is well known. They are now manufactured by licence in no less than fourteen different countries. Among the many descriptions given, the following are also illustrated :—English A.D.C.—Cirrus 4-cylinder, 85–95 H.P. (*cf.* de Havilland Gipsy) ; B.M.W.'s V 6-cylinder up to 410 H.P. ; Mercedes-Benz engine up to 1,000 H.P. ; B.M.W.'s VIa 12-cylinder up to 750 H.P. ; new 850 H.P. Junkers " L 88 " engine ; new 700 H.P. Argus VIa engine with hanging cylinders ; new 600 H.P. Siemens-Sh 20 9-cylinder (*cf.* Armstrong-Siddeley Lynd, Salmson, etc.).

(*c*) Accessories. These, owing to the civil character of the exhibition, did not include armament. Propellers (metal *v.* wood), carburettors, magnetos, petrol pumps, crash-proof tanks, Farman gears, and instruments are all shortly dealt with. As regards the latter, England and America were best represented. The author considers that German instruments are so far superior that there should be possibilities in the way of export, especially since the universal support afforded by Governments to aircraft and engine-production is not extended to accessories.

It is precisely in the matter of accessories that Germany stood much worse after the War than, for example, in aeroplane construction. The Exhibition shows that the leeway has been made up. This applies more to equipment than to engine accessories. The Exhibition proved a real success, of which evidence should be found in increased trade.

F.A.I.

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CORRESPONDENCE.

MOTHER SHIPTON'S PROPHECY.

To the Editor, *R.E. Journal.*

SIR,

In the March number of the *R.E. Journal* was published over my initials a copy of Mother Shipton's prophecy. Shortly afterwards my attention was called by a reader to an opinion that Mother Shipton was a legendary personage, and that the whole doggerel was a fabrication. It has taken some time to find the opportunity for a search in the books on the subject at the British Museum, but the result may be of interest.

There appears to be no doubt that Mother Shipton was not only a reality, but that she was also looked upon as a "wise woman" about the year 1530, and that she lived near Knaresboro', in Yorkshire. As early as 1645, W. Lilley published a collection of prophecies including some of those of Mother Shipton, and it was then considered that some of them had been fulfilled. In Stuart times, there was a general belief in her predictions, of which the two most famous were that Cardinal Wolsey would not enter York on his last journey, and that London would be destroyed.

In the *Life and Death of Mother Shipton*, written by Richard Head and published by W. Harris in 1687, the writer says "A stone was erected near Clifton, about a mile from the city of York, from which the following epitaph is taken :—

"Here lyes she who never ly'd,
Whose skill often has been try'd,
Her prophecies shall still survive
And ever keep her name alive."

But about 1862 a Prophecy in rude verse under her name was put into circulation by a Charles Hindley, who confessed to the fraud ten years later (*Notes and Queries*, April 26th, 1873).

In his *Mother Shipton Investigated*, in 1881, W. H. Harrison thinks that more than half, possibly the latter two-thirds, of the doggerel given on pp. 183–4 of the *Journal*, were written by Hindley at a time when lampoons were rife and political hopes and desires were being published in the popular form of prophecy. I also find that, in its original form, Hindley wrote the last line as :—

"In Eighteen Hundred and Eighty One."

I would therefore like to apologize for having inadvertently asked you to publish a fabrication, and to thank my critic for his information. I have heard the verses as published from many sources from my youth, and have never heard a doubt as to their authenticity before. It gives more point to the laconic advice of a celebrated personage to a young friend who asked for counsel and wise instruction before entering upon a new field of activity ; his sole message was : "verify your references."

D.M.F.H.

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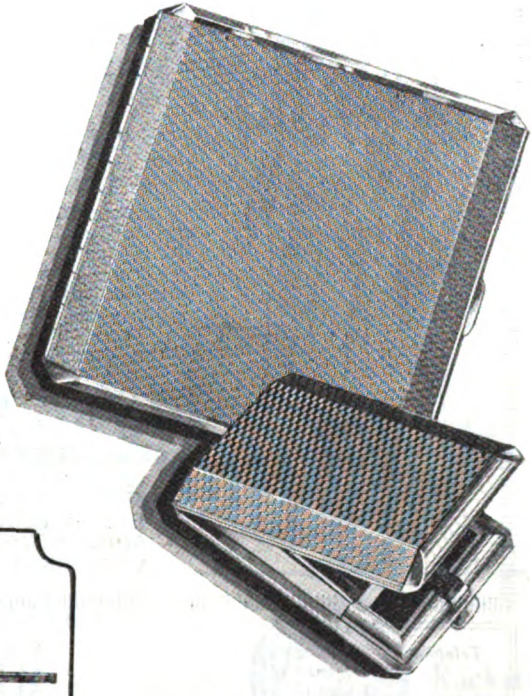

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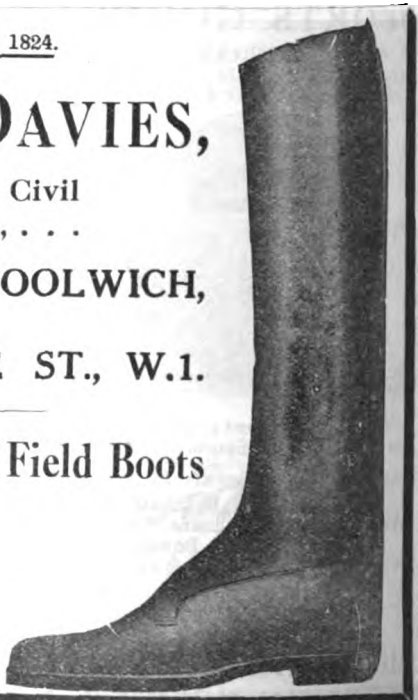

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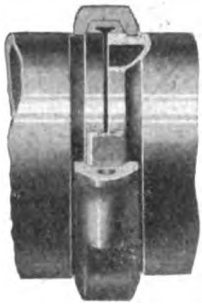

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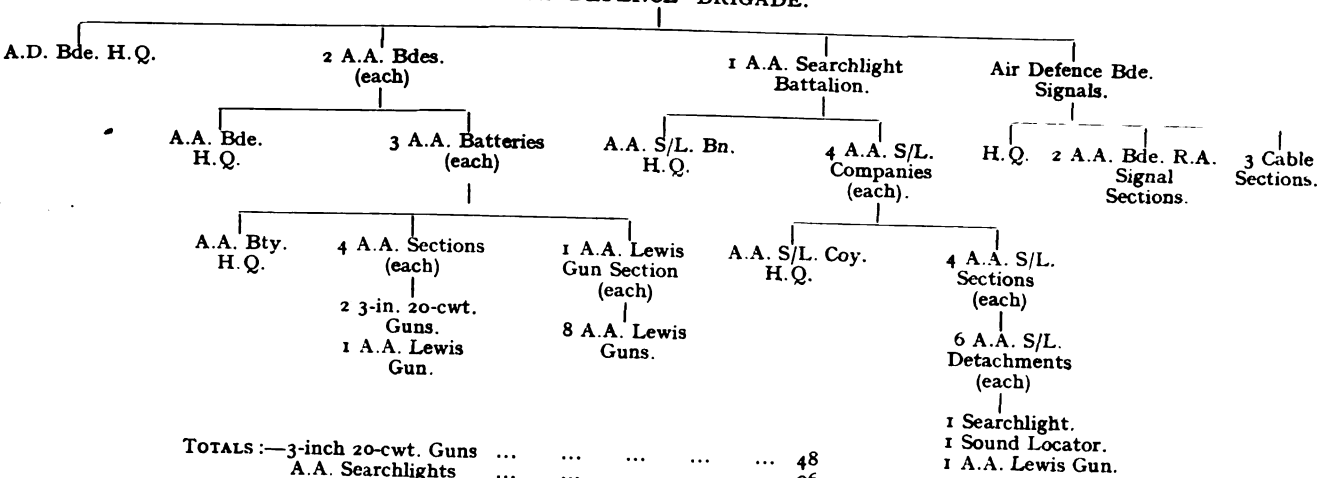

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MILITARY MINING IN THE GREAT WAR.

A Lecture delivered at the S.M.E., Chatham, on November 14th, 1929, by MAJ.-GEN. R. N. HARVEY, C.B., C.M.G., D.S.O.

I HAVE been asked to tell you something about the mining operations in France during 1915, 1916 and 1917.

In order to meet the requirements of the situation, it was found necessary to create a new and distinct branch of the Staffs at G.H.Q. and Army Headquarters, and to raise a brand new group of companies of R.E. These were known as Inspector of Mines at General Headquarters, Controller of Mines at Army Headquarters, and the tunnelling companies.

Now as I believe that, in any war against a European nation, similar steps will have to be taken, I shall explain why these new Staffs and new units were necessary, so that if any of you are holding important appointments either on the General Staff or as Engineer-in-Chief in those days to come, you may be able to start where we left off, and not have to start from first principles as we did.

The Germans began to mine almost as soon as the line stabilized and blew their first mine about New Year's Day, 1915, at the Brickstacks south of La Bassée Canal.

Immediately there were insistent demands for means to combat this fresh menace. Units called Brigade Mining Sections were hastily improvised by amalgamating a section of a Field Company R.E. with such officers and men who were miners in civil life, and who could be spared by their units in the Formation. This was merely a makeshift, which destroyed the organization of the Field Company and depended upon the popularity or unpopularity of mining in the area as to what support it got from the infantry commanders.

It was recognized almost at once that properly organized companies of officers and men, who made mining their profession in civil life, must be raised to take over mining entirely. I must point out here, that, in my opinion, the training of any R.E. Company can never make it an efficient unit for mining in any but the easiest geological formations. A good deal can be learned in theoretical principles of planning defensive or offensive military mining, but to be an efficient miner, you must have years of experience underground, and miners do not enlist in the R.E.

I will not weary you with the description of how the companies were formed, but the establishment of a tunnelling company was

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about 25 officers and 330 men, organized into H.Q. and four sections, each section capable of mining three headings with *continuous* work. To each company were attached, as a permanent fatigue party, 120 infantry.

The commanding officers of these units were at first specially selected officers, who had distinguished themselves with the field companies, but this had to be given up, for the casualties among the field company officers were so heavy that this source of commanding officer was soon exhausted. The tunnelling officers were then called upon to produce their own commanding officers, and they rarely failed to produce any but the best. The tunnelling companies were formed as occasion demanded. Their final numbers were: British 26, Australian 3, Canadian 3, New Zealand 1, total 33.

The units were allotted to armies, but were practically placed at disposal of brigades.

So much for the tunnelling companies. I'll tell you about the Inspector of Mines later on.

MINING IN 1915.

Mining in 1915 was a series of individual efforts by each tunnelling company, to carry out the wishes of the Brigadier to whom it was allotted. It was a sort of underground scramble to get on even terms with an enemy who had always got some weeks' start.

These conditions were almost as trying as any could be, and called for the highest form of courage and self-devotion, and the miners proved that neither quality was lacking in them, at any rate.

There was only one general action in which miners took a prominent part, viz., the capture of Hill 60. Here four mines, of 6,000 lb. each, were used; the mining was carried out under the direction of the C.R.E., Lt.-Col. D. M. Griffiths, D.S.O. The operation was successful, and Hill 60 was held by us for a month, when the troops were driven off by the second gas attack of the War.

Most of the offensive mining of 1915 was devoted to what I call ornamental destruction, which is the demolition of individual snipers' nests, O.P. and M.G. outfits. These were frequently fired to celebrate some day of public rejoicing, Brigadiers' birthdays, and so on, but in no connection with any infantry operation. This sort of mining is perfectly useless for ending a war, it is very unsettling for the occupants of the posts blown up, certainly, but the *straf* which always followed made our trenches most unhealthy.

I consider that 1915 was the year of preparation. Tunnelling companies were being formed and gradually trained in their special work. The equipment was slowly got together, selected from the best of prehistoric ordnance stores, and articles which had been purchased by private effort. The mine rescue apparatus was a relic of the Crimean War; ventilating fans made a noise like a motor-car,

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and always drew fire. There were no surveying instruments suitable for use in a gallery, 4 ft. 6 in. x 2 ft. 3 in., the ordinary size we used in France. There was no listening apparatus, and even the explosive ammonal had to be invented, for the navy wanted all the guncotton available. As a matter of fact, ammonal is far better than powder or guncotton. Mining was further handicapped by the fact that for some months of 1915 there were no accurate maps of the trenches, so you can imagine the difficulty of mining from a shaft in an indeterminate position, and to keep direction of the gallery against a point distance unknown, and only to be glanced at in bad light, or when the enemy wasn't looking. Mining attracted a good deal of attention to itself because of the frequent calls for more mining companies, and the complaints of the C.O.s from whom miners were taken to form the companies, so that towards the end of the year, G.H.Q. began to make enquiries as to what had been effected during a year of mining.

There wasn't much to show, except the fact that the infantry were holding the same line which they had taken over in 1914, in spite of the fact that the enemy had been trying to blow them out of it almost continuously.

Underground, there were in nearly every sector and sub-sector of the line, a tangle of galleries running out from *one* shaft, because there had never been a chance of sinking a second one.

G.H.Q. had, up to this time, no accurate knowledge of what had been done; the reports which should have been rendered weekly on a properly ruled form, never got as far as G.H.Q., or if they did, they were hopelessly out of date. So it was decided that there must be closer touch between the G.S. at G.H.Q. and the mining operations; and the E.-in-C. was asked to nominate an officer to be styled Inspector of Mines at G.H.Q., and one officer in each army called Controller of Mines.

That is how the appointments of Inspector of Mines and Controllers of Mines came about.

I was in the E.-in-C.'s office at the time, and I was told to draw up the duties of Inspector of Mines. Knowing well the difficulties we had had in getting up-to-date information from the front, I drew up a charter for the I. of M. which would enable him to visit any mine, anywhere, and at any time, without any reference to the Headquarters of any formation, except to tell them he was going into their areas, and added the ordinary duties of an inspector.

To my surprise, the G.S. at G.H.Q. accepted it, for it gave the I. of M. more freedom of movement than anyone else in France, except the C.-in-C. himself.

After this job had been refused by one R.E. officer, I asked the E.-in-C. to nominate me, and to my great satisfaction, he did so.

And that is how the Inspector of Mines and the Controllers of Mines came into existence.

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The first step taken by the G.S. was to lay down the principles on which mining in future was to be conducted. They were :—

1. No offensive mining, unless it formed part of a definite military operation on the surface.
2. Defensive mining in all sectors to be confined to the offensive —defensive.

The C.-in-C. authorized at this time the use of deep mines as part of the operations against Messines.

Under the new organization began a new era for the tunnelling companies. They were removed at once from the control of the Brigadiers, and came directly under the Controller of Mines of the army who represented the G.S. for mining work.

The principal duties of the Inspector of Mines were :—

1. To see that the directions of the G.S. as regards offensive mining were strictly carried out.
2. To ensure that the mining defences in each sector were designed on a definite plan.
3. To keep the G.S. constantly informed of the progress made with such mining as was intended to form part of a general operation.
4. To report the result of such mining after the operations.
5. To advise the G.S. on the question of transfer of tunnelling companies from one army front to another.
6. To watch the interests of the officers and men of the tunnelling companies as regards appointments, reinforcements, supply of stores and equipment.

The duties of the Controllers of Mines were somewhat similar as regards the G.S. of their armies.

The staff of the I. of M. was as follows :—

2 staff officers.
1 geologist (a necessity on all mining staffs).
1 medical officer (specially versed in diseases of miners).
1 mechanical engineer.
Clerks and draughtsmen.

Reports went straight from the Controller to the Inspector of Mines, and thus direct touch was established, which became more and more close as the I. of M. began to inspect the front and learnt his job.

In the office of the I. of M. were kept all the mining records, and from it was issued propaganda of all sorts to the companies. All experiences which came to notice and were of general value were broadcast ; everything was done to do away with watertight compartments ; the achievements of one company were published and sent to all companies and produced the keenest rivalry.

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Every effort was made to standardize the articles of equipment, and to ensure that what was available should be fairly distributed. Standardizing equipment was more difficult than you may suppose. The tunnelling officers were all mining engineers, from any part of the world, and they had enormously strong prejudices in favour of the things they had used themselves. However, we managed compromises in most things that had to come from England, but where the army workshops could make any pattern at all without check standardization was impossible.

Each army started its own mine school. At this, instruction was given in listening, mine rescue work, life-saving and mine tactics. These schools were essential for training officers in their work before they went up to the trenches, so that they would not have to learn it under fire. Our mine rescue apparatus now was the same as is used in the mines at home, and was the means of saving many lives. Listening was the science which was developed to the highest extent at the schools, and we got surprising results from the careful training of selected men.

When we started mining in 1915, we thought that ten feet of clay, or thirty of chalk, was sound-proof. In 1917, our listeners were so skilful, that they could correctly estimate distances up to 80 feet in clay or chalk, and differentiate between the sounds they heard, shovelling, picking, talking, laughing, etc.

We eventually got a very efficient and silent ventilating apparatus, but for a long time, ordinary forge bellows were the best means of supplying air, being almost silent. Anything like a rotary fan noise immediately drew heavy *straf*.

The first combined operation infantry attack, assisted by mining, took place in April, 1916, at St. Eloi. Here, four heavy mines, originally intended as part of the plan for Messines Ridge, were fired; these were 60 feet deep, our first deep mines. They were a useful adjunct to the operations which were at first successful, but eventually the craters were lost, as nearly always happened with British troops, and it was a case of "as you were," until June 7th, 1917. From these mines, we learnt what sort of clay the subsoil was, and the real effect of very heavy charges and the crater formed, also the appearance of a heavy mine when fired, the range of the flying debris, and time taken for falling fragments. All these were carefully noted for future use.

The next combined operation was the Somme battle.

This opened on July 1st, 1916. We had six or seven mines under various strong points; all were fired at zero, except one, which for some reason or other was fired at ten minutes before zero. This was done in spite of my earnest protest at G.H.Q., for I knew that, as soon as the crater was formed, it would be occupied by the Germans. This actually happened, and it formed an excellent advanced

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post from which the enemy enfiladed "No Man's Land" with machine-gun fire.

Compare this result with another sector of the line, where the mine was blown at zero. No less than nine dugouts, containing the garrison of the trenches, were closed in, and our troops crossed "No Man's Land" with hardly a casualty.

In another place, the tunnelling officer who had to fire the mine was working at the junction of two brigades; he had his time from the right-hand brigade, and thought it must be the same in the other brigade, but after having made a final test of his firing apparatus, he returned to the trenches, having, as he thought, one minute in hand, when he saw, to his horror, the infantry forming up to go over. He rushed to his exploder and fired his mine, which was quite successful, and destroyed the enemy post, but several of the assaulting troops were temporarily laid out by falling lumps of chalk and clay.

Other mining assistance took the form of Russian saps from our trenches towards the German front line. These were tunnelled out about a foot beneath the surface, and the idea was that they should be opened up and connected with the German trench immediately after the first wave of infantry had gone over.

I think there were about 25 tunnels from first to last; some were never used, as the troops failed to get across; some were not required, because the Germans cleared off altogether; but in one or two instances, it was by means of Russian saps which were connected up with the German trenches that our troops were enabled to hold on to the portions they had taken, for by these covered ways alone could reinforcements get through to their destination without having to go across a machine-gun swept "No Man's Land."

Several tunnelling officers had unique experiences in this battle, in areas where the assault failed. They had been chosen to take charge of the working party, to connect up the head of the sap to the German trench. At each saphead was a m.g. or Stokes gun emplacement. The tunnelling officer and the gunner sat at the head of the sap, within 50 yards of the German trenches, anxiously waiting for the advance of our troops. They had a wonderful, but at the same time, a most heartrending experience, for not a man passed them. The lessons from this battle were carefully scheduled for future use. They were:—

1. All mines must be fired at zero, so as to run no risk of the craters being occupied before the troops cross "No Man's Land."
2. The synchronization of time is of absolute importance, and the tunnelling officer must be certain that he is right with the H.Q. of the troops he works for.
3. Russian saps have solved the difficulty of crossing "No Man's Land."
4. Our theoretical calculations were proved correct by actual practice.

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After the battle of the Somme, we had ample opportunity to study the German mining methods, and found that :—

1. They hid their spoil, so that there was no evidence from air photos where their mines were ; our dumps, on the contrary, were mounds of chalk, visible for miles to the naked eye. This point was stressed with very good results at the Messines mines.
2. They were meticulous in their gallery work, and lined with wood the hardest chalk.
3. They marked up on the wood lining, where they started work and finished, and from this we got the information that they reckoned to do eight feet a day ; our pace was *ten to fifteen*, which accounts for our being able to catch them up.
4. A complete suryey of the German mine systems was made, and from it many strange occurrences were accounted for.

Among the treasure trove, we found diaries of mining officers which, contrasted with the reports of our own officers, made amusing reading, for each side invariably reported their mines were entirely successful, and those of the enemy utterly harmless.

The last combined operation of 1916 was the Battle to take Beaumont Hamel. Hawthorne Ridge crater, which was occupied by the Germans since July 1st, was attacked by three mines, which were fired at zero, and this ended in complete success.

After the Battle of the Somme, we had in our possession the whole of the German mining systems of any importance south of Arras, and the tunnelling companies were employed in making underground shelters for the troops, and I estimated that accommodation for about 20,000 men was made for the winter. These numbers were compiled from reports of dugouts actually made.

The year 1917 was the miners' final triumph. The first combined operation was the battle of Arras, which included the capture of the Vimy Ridge. For this operation, all the information we had collected from experience of 1915 and 1916 was placed at the disposal of the Controller of Mines 1st and 3rd armies.

Mines did not form a very large part, but Russian saps were developed in a striking degree.

For the Vimy Ridge, only twelve were made, but on a much larger scale than before.

Instead of being only 12 in. underground, they were made shell-proof, that is, 25 ft. thickness of head cover. They were 6 ft. 6 in. high and 3 ft. wide, to allow men to pass through, standing upright, and wide enough for two armed men to pass. These subways were lit throughout by electric light, a water supply was laid on, and all along the subways were made dugouts, assembly chambers, dressing stations and formation headquarters.

They were run out to within 100 feet of the German line, arrange-

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ments were made to connect the head of the subway with the German trenches by means of bored mines at a depth of 12 feet, *i.e.*, a bore hole, lined with a steel tube, which is afterwards loaded with H.E., which when fired formed an irregular trench, 30 ft. wide and 14 ft. deep; this was quite good enough to be converted into a covered way. These subways were a complete success and the Vimy Ridge was taken according to plan.

The leading feature of the Arras Battle from an underground point of view, was undoubtedly the exploitation of the "Caves" of Arras.

The caves are in reality the underground chalk quarries from which the hard chalk was taken to build Arras in the sixteenth century. Some few of them were found and used by the French as bivouacs, and these we took over. A few were found by chance, and then began a systematic search in which two main series were found.

These caves were, as a rule, not connected when we found them; they lay roughly in the line of the main roads leaving Arras, and approximately in the direction of the main attack.

The two systems were converted into a series of huge dugouts, in which nearly two divisions of infantry were housed, with their formation staffs, for some days before the battle began.

It was also found that a small river, called the Crinchon, had been conducted by a brick sewer, two metres in diameter, round a portion of the town; this sewer was also brought into the scheme and connected with the tunnels and the caves. The result of this was that troops could proceed underground from the centre of Arras to within 100 feet of the German trenches, under cover, and this was actually done, a total distance of about three miles.

The caves provided almost ideal accommodation, and were fitted out like a camping ground, with wash-houses, cook-houses, latrines, store-rooms for every conceivable store, lit by electric light, and ventilated by enormous rotary fans; they were a hitherto unknown feature in field warfare.

Great care was taken to obviate any danger from falls of chalk, even under the heaviest bombardment, and the precautions taken were entirely successful, no case of injury to any man occurred, and no case of penetration by an enemy shell occurred either.

The survey of the German mine systems, made after the battle, did not produce any important information, though it was quite evident that from the style of work they left, the majority of the skilled miners had been withdrawn, and the work was that of ordinary pioneers.

The general success of the underground work preparatory to the Battle of Arras was circulated to all companies, and G.H.Q. ordered that, if possible, the system of subways should be tried in the Messines area, and included in the underground work which was already approaching completion for the impending operations.

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But the subsoil for a depth of not much less than 40 feet was far too treacherous to allow of subways being constructed, except with an enormous expenditure of time, material and men, none of which essentials were available. It was the treacherous nature of the ground that decided us to lay down that the minimum depth of any mine intended for the Messines Battle was to be 60 feet. Even at 70 feet, I have seen the 7 in. x 4 in. uprights of a gallery (only 4 ft. 6 in. x 2 ft. 3 in.) broken across their wider axis by the weight of the roof.

The blue clay in which we were working would not hold its own roof, unless it was continuously supported. In this respect, the mining in Flanders was far more difficult than similar work in the chalk areas.

The preparations for the Messines battles had been commenced in 1915, with what was known as the Berlin Tunnel at Hill 60. This tunnel was a long, inclined gallery, to a depth of some 60 feet, through a very wet and treacherous subsoil to the blue clay. It was from the experience gained by the construction of this inclined gallery that we decided that all shafts to mines in Flanders must be vertical.

Mining had been commenced in August, 1915, and was completed only on the very eve of the battle on the 6th June, 1917. Of 19 which were detailed to be fired on the date named, 19 mines went up.

Now it must not be supposed that this work was all plain sailing, though we were deep. Somehow or another, the Germans got to know that we were mining deep, and during 1917 made determined efforts to defeat our progress, but though only one mine was lost in this dispute, our galleries were broken on three other occasions.

At Petit Bois, our gallery ran under an old crater in " No Man's Land," which was occupied by the Germans, and as luck would have it, they heard us working below them ; they blew a counter mine, which wrecked 150 feet of our gallery, and cut off 12 men. Although every effort was made to rescue them, by the time a new gallery was made round the break, ten days had elapsed, and when the rescue party broke into the gallery beyond the break, they found, as they thought, all the men of the original party dead. They went back to dinner, and, on their return, were scared to death at meeting a survivor crawling towards them. He was an old miner and had remained at the face where he knew the air was better ; he had heard the rescue party break in, and had crawled down to meet them. Unfortunately, the doctors had him out of France before I could interview him.

Remember that this 150 feet of new gallery had to be made with every precaution against being heard by the Germans above, and the miners working there ran the risk of being cut off exactly as the men whom they were trying to rescue had been. But miners will

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never abandon a pal while there is the slightest chance of rescuing him; that is one of their creeds.

Another gallery was wrecked quite close to the charge, which had been already laid and tamped, cutting all the leads. This gallery was recovered, the charge was reinforced with a priming charge of 1,000 lb. of guncotton, and everything restored to order, only six hours before zero. It was duly fired according to plan, and H.M. The King was photographed near its crater on the occasion of one of his visits to France.

A third gallery was destroyed at Hill 60, at the vital point of the junction of two galleries to two different mines, but by the most strenuous work, everything was restored to order by zero, and the mines were fired, and were both eminently successful.

When we had taken the enemy system of mines and carefully examined them, we found that in three places at least, they had commenced to mine even deeper than we were; we found shafts of varying depths up to 90 feet.

Hill 60 mining was one of the most difficult and dangerous propositions the miners had.

Mines were in three levels :—

Top level. Shallow system commenced in 1915; scrapping went on at this level nearly all the time.

Middle level. This was developed by us to counter a German effort at the same level. On this level we found a German gallery which had passed ours and was 150 feet behind our front line.

Low level. The mine galleries for the Messines battle.

The Germans heard us from the middle level, and blew a charge directly over the junction of Hill 60 and Caterpillar galleries, and cut all the leads. These two mines were actually recovered, though we heard the Germans working above. We couldn't afford to blow them, for this would mean retaliation, with probable damage to the two main mines. As we estimated that their gallery would miss our system, they were allowed to go on working, and were working at zero, 7th June, 1917.

In the preparations for the Battle of Messines, we made use of all the experience which had been collected in the previous two years. We knew the general appearance of a mine; we could tell accurately the dimensions of the crater.

We knew how long to allow for the debris to fall, and the area affected by the gases produced by the firing of the enormous charges.

But we did not know what the effect of the earth shake would be on the surface.

Regulations had to be drawn up to ensure against casualties

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being suffered by our troops. Generally speaking, they were as follows :—

1. No troops to be within 200 yards of a mine.
2. All trenches to be empty at that distance.
3. All dugouts to be empty within 300 yards.
4. No troops to be in or near shell-shocked buildings or trees.
5. No troops to advance until 45 seconds after zero.
6. No troops to attempt to cross a crater or its lip.

The regulations were sufficient, and no casualties, as far as I could learn, occurred, except in the case of men entering craters against orders. These men were gassed. I found out later that men ought to be told that mines would be fired and what they would be like.

The battle was a complete success from a miner's point of view, in that we scored a possible 19 mines out of 19 fired ; some of the mines had been underground for 15 months.

The other side of the picture, however, must be considered. A very important number of the divisional commanders were urgent in their demands that the mines should not be fired ; the reason given was that the craters would limit the front over which their formations had to pass, and when you think that the craters in question were, on the average, 100 yards wide, there is a good deal in the objection. But the higher command ruled the objection out. We do not know what casualties were inflicted on the enemy, but we do know we caught two German companies at Hill 60, relieving one another, for we picked up alive the O.C. of the company relieved, and none of his company or the other were among the prisoners ; and we caught German troops forming up for a raid in the craters of St. Eloi, only one scorched German was found of this party.

The crater of this mine is the one which has been written about in *The Times*, and called " The Pool of Peace " ; there is a suggestion that it might be preserved as a sort of war memorial.

A curious rumour was started early in the morning of the battle, that heavy German mines had been blown in our support lines. On investigation, this must have been due to men or troops in salients in our line seeing mines go up apparently *behind* them, but in reality behind the German trenches in our re-entrant angles.

This will be readily seen on a map and is, no doubt, the reason why the Germans in Hill 60 and St. Eloi, thought our mines on the right flank had blown up the town of Messines. Our nearest mine was about a mile from this town.

For this and all succeeding battles, great attention was paid to providing dugouts for the Headquarters of all formations, down to battalions. As the Battle of Messines was one of limited objectives, this could be done, and was done, with the result that A.H.Q. was in much closer touch with the battle than had been possible before.

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This system of providing dugouts for headquarters was developed very widely, and the lesson we were supposed to have learnt about the careful disposal of soil was again impressed upon us.

In Flanders, we had to get down to the blue clay, but woe betide the miner who showed this material on the surface. One instance I saw; we were making a dugout for a headquarters in an exposed position after the 7th June. Some blue clay had been spotted by the Germans, and I counted 13 hits on the immediate area by 8-in. shells, four of them direct over the dugout.

I am afraid there is no time to tell you stories of the wonderful feats performed by the miners; I have confined my remarks to the lessons learned from them, and you may be perfectly sure that, if you remember the lessons I have pointed out, the miners will always produce enough feats of valour to make stories of in your day.

I will conclude my remarks by the rather paradoxical advice. If you are in a position of responsibility in the next big war, do everything you can to prevent mining being done, except for strictly defensive purposes. In a long position taken up, there must, of course, be important features which are like the bastions of a fortress of ancient days, and which must be held at all costs; a mining defence here is legitimate, but wholesale mining under the front trenches should be discouraged. It is far better to sink listening posts and, by their aid, find out where the enemy are, and then to withdraw the line sufficiently far to prevent the enemy from occupying the old trenches, and at the same time throwing upon him the labour of another 50 yards or so of mining. This system was adopted by the French to a large extent and I am sure it is sound.

It is not generally known how mining eats into the infantry strength of an army, but when I tell you that I took a rough census of the number of men employed underground at a certain date in 1916, and the numbers were about 20,000, that is, two divisions of infantry, you will understand why I say cut down the mining to the lowest possible limit. No modern army can stand this drain on its strength.

Miners will always be required for making underground shelter for headquarters of all formations, numbers of troops, stores, etc.

This is useful mining, but in modern days with aeroplane bombs, heavy artillery, and all these other bolts from above, the blow from below is far too slow in progress, and cannot be readily adapted to the ever-changing schemes for the occupation of trenches on the surface.

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THE ENGINEER SCHOOL OF VERSAILLES.

By GENERAL ROBERT NORMAND.

(Reprinted by permission from *Revue des Deux Mondes* of March 1st, 1929.)

"*Ad victoriam per scientiam.*"*

ON 5th March, 1927, when placing a Colour for the Engineer School of Versailles in the Marble Hall of the Castle, at the same time as for its sister school, the Air School, the President of the French Republic decorated the former and pronounced the following words:

> "By the part they took in action, by their military works, by their successful inventions, the officers of the Engineers contributed largely to the victory. As a recognition of their services the President of the Republic has decided to decorate their Colour.
>
> "Colour of the Engineer School, we make you Chevalier of the Legion of Honour."

This great recompense constituted a striking recognition of the training given to a group of officers, too many of whom unfortunately fell in the Colonies, and 700 of whom gave their lives for France in 1914–1918. It clearly defined the double character of these military engineers: soldiers and scientific experts. The Army inspires a sense of duty, science develops the character. It is not surprising that this double training provided us during this great war, as during those of the revolution and the colonial campaigns, with a magnificent Corps of incomparable engineer officers.

Amongst the great names of the War do we not see standing out in the first rank that of a "Sapper," who has had a long and magnificent colonial career, Marshal Joffre, whilst two of the greatest figures of the war of 1870 were those of two other Sappers—General Faidherbe, another colonial, and Colonel Denfert-Rochereau? Further back in the past and not so very long ago we also have Lamoriciere and Cavaignac—two heroes of the Conquest of Algeria—who joined the Engineers after passing out of the Polytechnic School. Lazare Carnot and Meusnier, during the Revolution, came from the Engineer School of Mezieres, which dates from 1748, and to which we also owe

* Motto of the School, suggested by Cadet Officer Schott.

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the celebrated electrician Coulomb, the mathematician Poncelet, and the inventor of the first steam-driven vehicle, Cugnot.*

THE "NURSERY" OF THE ENGINEERS.

The school at Versailles is a recent creation. It was in 1884 that a new military school of artillery, engineers and train was installed in this old garrison town, with a view to giving certain N.C.O.s the extra training necessary for promotion as officers. Whereas the officers promoted automatically as 2nd-Lieutenants on leaving the Polytechnic continued to carry out their two years' study at the Artillery and Engineer (Advanced School) *Ecole d'application* of Fontainebleau, since 1871 the successor of the *Ecole de Metz*. These mixed schools had disadvantages as against obvious advantages, such as the *camaraderie* between "gunners" and "sappers." Moreover, if the School at Fontainebleau was very well equipped for practical artillery exercises, it was very badly equipped for those of the Engineers, and it was difficult to remedy this. Therefore, in 1912, it was decided to create a Military School of Engineers at Versailles to train in the same establishment—but with different courses—the *officiers-élèves*† and the *élèves officiers*‡ of the Engineers.

During the War this school worked, like a workshop with full output, in training the *aspirants* of the Engineers, designated for providing the future Army with officers, once these had been tried in the field. For, besides the great expansion of the Engineers necessitated by the most varied requirements, it was also necessary to fill up the officer cadres, since the losses which occurred in the four years through casualties involved a loss of about twenty annual promotions on the active list.

After the War, the school tended more and more to become, and is to-day, the cradle of the Engineers; in 1925, it assumed the name of *Ecole militaire et d'application du Génie*, and in reality comprised two parts:

Ecole militaire (the military school), a training school, comprising one year of study for the probationer officer of the "active" Army and the administrative probationer officers (until 1926 the latter were at the *Ecole de Vincennes*), a half-year for the probationary reserve officers.

Ecole d'application (advanced school), comprising: two years' study

* In 1770. It is to be seen at the *Conservatoire des Arts et Métiers* in Paris. The School at Mezieres also produced Rouget de L'Isle, the author of the "Marseillaise," a sub-lieutenant at the School in 1782 and nominated probationer sub-lieutenant in the Royal Corps of Engineers on April 1st, 1784, after being rewarded with the following notes: "Has but too much confirmed the impression which he gave last year of having little liking for his profession and only working as much as he is obliged; in the carrying out of his work he showed such carelessness and stupidity as to prove that he has no ambition. His character is gentle and honest, but he is very addicted to dissipation and futile things."

† Officer students. ‡ Probationer officers.

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for the most efficient officers (who have been through the Polytechnic or other officers having a sound technical knowledge and having chosen the " active " Army) ; one year's study for former probationer officers or those having lower technical knowledge, especially the majority of the officers admitted to the Engineers with a view to absorbing the surplus of other arms resulting from war nominations ; six months' study for the officers who have passed through the Polytechnic classified as reserve officers of the Engineers, and who, as probationer reserve officers, should complete their legal term of service in a regiment as reserve officers.

The result is that, with the exception of a few *adjutants** promoted officers without examination but obtaining this favour by practical work, by seniority and long and loyal service, or ex-re-engaged N.C.O.s promoted reserve officers having obtained the certificate of the *Chef de Section* (section commander), no one can become now officer of the " active," reserve, or administrative, without having passed through the school.

Since, moreover, the newly promoted battalion commanders are called upon to go through a course of one month, and the general officers and colonels come to a refresher course at the Centre of Tactical Studies of the Engineers, we may conclude that this school is in reality the " nursery " of the Army.

An Arm with Multiple Roles.

The first phrase of our Regulations states that " the Engineers are a fighting arm."

During the War, it was given the most varied and sometimes the most unexpected missions, such as flame projector companies, the exploitation of woods, even at some moments the work of bombers and the construction of hand grenades. Its regiments were more and more transformed into lines of communication and signal units : for the former, roads, tracks, fixed or floating bridges, construction and working of railways of normal gauge† : for the latter, the installation and working of telephone, telegraphic and wireless systems, intercepting of enemy wireless, carrier pigeon service, and designing and construction of apparatus answering to the needs of war, such as those of ground telegraphy.

Further, the " sapper-miners " normally responsible for fortifications, concrete works, camouflage, destructions, mines, took part side by side with their infantry comrades in all the assaults, both for destroying the obstacles or enemy shelters as well as for connecting up captured positions with the jumping-off points. Under this

* Serjeant-majors.

† The Engineers constructed 7,000 kilometres of normal gauge, 4,000 metres of military bridges, and 4,100 metres of piles for normal gauges. Since the War, they have also been made responsible for the narrow gauge lines formerly constructed by the artillery.

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heading we find to their credit innumerable acts of heroism, thanks to their wonderful *esprit de corps.** Necessity often led them to take part in actions as infantry, although this was not their role. For " the Engineers are the working arm " states the Regulations. And this conception in itself is potent.

The " sapper " has, nevertheless, one monopoly in the struggle which no one will begrudge him ; that is the war of mines, with its surprises, its ruses, its snares. Certain war cemeteries are exclusively filled with miners buried by explosions at unprecedented depths. Sometimes the mechanical installations required for these works, with compressor installations, narrow gauges, lighting, trestles and electric pumps, constitute veritable subterranean factories, and after several years of labour we find works, for instance, such as those at the Chapelotte in the Vosges, with 11 tiers of galleries at a depth of 110 metres under the natural soil, and covering an extent of several kilometres. The mine chambers sometimes contained 40 tons of explosives, and produced craters of 40 metres in diameter and 20 metres in depth.

The Engineer Service was also responsible for camps and quarters, for the whole of the road system of the Army zone, the water supply, the installations and the exploitation of electric lighting, the construction of material for quarters and fortifications.†

The technical role of the Engineers must inevitably become accentuated in the future. Fortification permits of an economy of forces, inter-communication facilitates the exercise of command, railways accelerate the transport of troops and supplies. The regimental officer must possess engineering talents ; those of the administrative services, or the Engineer commanders, must combine the qualities of a staff officer with that of an industrial head manager.

This diversity of functions is, in fact, one of the characteristics of the Engineer, and, above all, the post-war Engineer. Besides the three great branches of the arm, miners, road makers, telegraphists, there are many more supplementary ones, electrical mechanics, bridge makers, transport sappers, heavy bridge makers, carrier pigeon attendants, and again the latter are even more numerous in the administrative services of the Engineers : construction, electricity, camps, administration of the military area, design branches, experimental committees, fortifications, roads and tracks, railways, and colonial public works, etc. The Engineers are, in fact, an arm both of the home country and of the colonies.

* We might mention here that the first French soldier who penetrated into the Douaumont Fort, on 24th October, 1916, was a sapper, the Master Artificer Dumont, who was decorated in the field with the Cross of the Legion of Honour, and received the following mention : " On his own initiative took command of four Colonial soldiers ; at their head he was the first to penetrate the Douaumont Fort, and captured four officers and 24 men."

† Thus they supplied 7,500,000 spades, 5,500,000 pickaxes, 960,000 tons of barbed wire, 325 million sacks of earth, etc.

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This variety of functions which the Engineer officer may be called upon to carry out, according to the vicissitudes of his career, his status or his abilities, constitutes the charm and the force of this arm. It is impossible for a man worthy of the name not to find one or several branches to suit his taste and his character. There lies the charm. It is also impossible not to find some means of employing the capacity and the temperament of each one to the best advantage; this is the force.

Students of Different Origin.

Let us now see how the instruction given copes with the preparation for these multiple tasks.

The diversity of origin of the students naturally influences the level of studies of each category.

The picked division, that is to say that which receives the highest practical instruction because it is prepared by the highest scientific training, is the *division d'application* (advanced division), which does two years' studies. It is mostly composed of former students of the Polytechnic School. Recruiting, in post-war years, fell off considerably, and was a cause of grave anxiety in the Army, one of the causes being the great needs of industry, which was also obliged to reconstitute its cadres; it was also a cause of anxiety for the Polytechnic School, which could not fulfil its essential mission of providing technical experts for the State. The crisis is now more or less over, and the engagements in the Engineers have fortunately risen these last three years. In 1925, 32 officers; in 1926, 46; and in 1927, 20 passed from the Polytechnic School into the Engineers, and they have nearly all remained in the Army. These figures are higher than those of 1910–13; they are almost sufficient for requirements. The very small deficit is easily made up from the new sources which have become available since the War, firstly from the other great schools, *Centrale, Ponts et Chaussées*—unfortunately in very small numbers—secondly and principally, from certain officers of the reserve who have developed a taste for the Army; finally, those officers who have come from other arms or the ranks, and possess sufficient technical knowledge to follow these higher scientific courses.

Nevertheless, an *Ecole d'application* (advanced school) cannot be a centre where theoretical studies will form the principal training. The instruction is, in fact, directed above all towards the practical side, in order to train officers to be capable forthwith of taking over their duties in the very varied career of an Engineer officer.

To this end, at least one afternoon per week in the winter, the student officers profit from the innumerable resources offered by Paris and its environs for visiting all types of installations and factories which bear upon their studies, from lime kilns, cement works, brickwork, up to the factories for dynamos, pumps, saw-mills,

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central heating installations, various laboratories and the geographical service, with its interesting annexe of plans of fortifications in relief, in the Invalides ; in the summer they are nearly always absent on visits to the frontiers, fortifications (north-east in the first year, south-east and Toulon in the second year), and the hydro-electrical region of the Alps, the mines and factories of Lorraine, comprising a study of the industrial organization of work and output, wherever this is possible. If we add the numerous topographical surveys and exercises for the defensive organization of the ground, the first rudiments of which they learn in the neighbourhood of Versailles, the more advanced side being carried out in regions favourable for the purpose or during their time in camp, and finally if we take into account the stay of a fortnight which the officers have made each year since 1927 in a regiment (Metz in the first year, Grenoble and Avignon in the second), we see that the training is not only practical and out-of-door, but that, while stimulating the spirit of observation and making them acquainted with the wonderful country which they will have to defend, it is also essentially varied.

The other divisions of officer students comprise both the former probationer officers, who are carrying out their second year of studies as 2nd-Lieutenants, as well as those who have been through the Polytechnic who have chosen one of the government careers which are connected with the Engineers (*Ponts et Chaussées*, Home or Colonial Woods and Forests, and the Post and Telegraph Engineers), or those who, in private business, choose this arm of the service as officers of the Reserve.* They all go through six months' preparation before their six months in a regiment, where they take a command. But nothing could be more homogeneous than this division, composed of young men endowed with a desire for knowledge, keen to learn, and who are on the threshold of life after a long period of school training.

Each of these divisions has a different mentality, due as much to the past training as to the future career which they have chosen. The work is heavy everywhere, for if it is difficult to train an engineer officer in two years, and even then incomplete, but sufficiently prepared to perfect himself in any given speciality, the problem with which we are faced is all the more complicated, when it is a case of a one year's course, based on a slight preliminary training—as, for instance, the six months for the reserve officers—even limiting it to training merely for regimental duty. It will be easy to comprehend that, for an Army which will, above all, be an Army of reserves, it is of capital importance that all these young men, coming from different strata of society, having different temperaments, training and ambitions, should mix together in everyday life. It is one of the most

* The new recruiting law will place the former students of the *Centrale, Ponts et Chaussées*, Mines of Paris and Mines of St. Etienne Schools on the same level.

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precious privileges of France, thus to be able to draw from all her resources, to avoid the single school, that is to say, the lower levelling.

" The single school would be impotent as regards touching all social *milieux* and attracting the different intelligences," wrote General Debeney. " Recruiting touches all social strata and calls upon all types of mentality ; the aim of professional training is to provide a methodical development of the intellectual flexibility of the race ; the ideal is to draw from the most purely national sources. This Corps of officers is not a caste . . . and herein lies the secret of its force."*

Nevertheless, we must—and this is the antithesis—melt it all down in one melting pot. Now if the exercises and the courses are nearly all separate, there are nevertheless some others which are common, and this is also the case in the daily life, mess, clubs, parades, fêtes, etc., excellent opportunities for creating the *camaraderie* and *esprit de corps* which are the best guarantees of cohesion.

At the moment when the Engineers, both on account of their expansion as well as inadequacy of recruiting, were very below strength, had absorbed officers of other arms which were in excess of establishment, infantry, cavalry, tanks—but especially infantry—technical instruction had to be given to all those who were capable of taking advantage of it. According to their abilities the latter were drafted to the division of those who had passed through the Polytechnic, or to a special division giving training essentially for regimental duties, but very few for the more technical engineer branches. Those who were considered less able were classified as accountant officers, thus relieving the more trained Engineer officers of these duties.

For lack of quarters the officer students have to live in town, at their own expense and without allowances, during the last few years even without a servant. This detail appears trivial, and yet it has a great importance, for the difficulties of everyday life and the expense incurred in keeping domestic servants obliges the Command to-day to be less exacting as regards uniform, accoutrements, and smartness, on account of the early hour of the first exercises ; and this has a disastrous influence on the training of young officers. If they have gold braid on their sleeves it is obviously so that they may appear commanders. Everything should contribute.

The military school is all under one roof. The only difference in *régime* is that all the probationer officers are quartered above their classrooms.

The probationer officers of the " active " army and the probationer administrative officers† are few, chosen from amongst candidates after a competitive examination—the number of whom is steadily

* See the article by General Debeney, " L'Officier," in the *Revue* of 1st May, 1920.

† These probationer administrative officers will no longer exist in 1929 by virtue of the fusion provided for in the new *Loi des cadres*.

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decreasing—drawn from a Corps of N.C.O.s who are also decreasing in strength and quality. The new measures taken with regard to re-engagements will no doubt improve these two factors in recruiting. But, owing to a severe training, these future officers, on passing out, are literally different beings to what they were at the time of their admission. The unit commanders declare that they are satisfied with what they receive. It is a just recompense of the trouble taken by the school instructors.

The probationer officers of the reserve—too long a title for the younger generation—quick and hustling—who write and pronounce it E.O.R.—constitute a subject of legitimate pride for the School of Engineers, as also for similar schools. Recruited from the principal technical schools *Centrale*, *Mines de Saint-Etienne*, *Arts-et-Métiers*, *Beaux-Arts*, *Ponts et Chaussées*, public works, different schools of electricity, etc., after an examination of higher military preparation, or coming from the contingent after a stay in a special platoon also followed by an examination, they form a body of picked officers carefully sifted after a stiff training. Further, it is a custom, in view of possible falling off of numbers, always to name more E.O.R.s to the admission of the school than there will be posts for officers on passing out. Hence an excellent stimulant, which combined with the perfect spirit which reigns amongst these young men, produces a *milieu* particularly favourable to emulation and a wonderful efficiency. A complete transformation is effected between admission and the passing out; the double military and technical knowledge acquired in six months is considerable. Moreover, all instruction is oriented towards the practical side. It may be said that there are hardly any courses, but exercises, mostly out-of-doors, a few indoor, the whole completed by examination on the regulations or the few general subjects which every officer should know.

These reserve officers constitute one of the most interesting elements of our regiments during the six months of service which they carry out on leaving the School. Only one objection arises. What becomes of this knowledge and these rudiments of experience a few years later, when life has removed them far away from the past studies? It is a fact that those who come back with the reservists no longer possess the same assurance, through lack of practice and keeping up with the subjects. Now, the first battles, which will be vital for the future of the country, will in all probability take place about the fifteenth day. At this moment our Army of reserve—in which, moreover, there will no longer be either "active" or reserve since everyone will be mixed up, and officers of the "active" army will be lost in the flood of reserve officers—should already have acquired its whole force.

It is, therefore, indispensable that the latter should keep in touch, not by furnishing lecture halls as audiences with a view to obtaining,

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thanks to a certificate of attendance, a free railway warrant, but by preparing for war, by the effort of decision and the habit of command. We must not mislead the issue for reserve officers, who sacrifice a part of their time at the expense of their profession, of their incomes, or their holidays, by making them follow oratory exercises. In war we do not talk, we act.

The taste of the reserve officers for the Army is shown by the number of officers who ask to enter the " active " army. But as it would be undesirable to get in by this way quicker than by the other, it was necessary to place an age limit. Despite this restriction the 20 or 25 annual posts offered are regularly taken, and some candidates have even to be refused. The test has been conclusive and the result gratifying. Those who choose the military career when older and after having tried another profession must in reality have the vocation. This is a very interesting source of recruiting ; a stay of one or two years at the School as officers of the " active " army completes their training.

As a total, about 500 Engineer officers pass through the School annually, both from the " active " army and the Reserve.

These young generations appear less gay, but more mature than their elders, hence equipped with a greater practical sense, more courageous also from the point of view of their matrimonial duties, of which they boldly accept the burdens, thinking that the nation will understand that it should assure them the means.

To stay still is to retrograde. The School progresses in full prosperity. A new jewel was added to its crown in 1926 by the creation of the *Centre d'études tactiques du Génie* (Centre of Engineer Tactical Studies) intended for defining the doctrine of the employment of Engineers in war, and to spread it in the Army, and particularly amongst the Engineer corps itself, where their routine duties often separate the officers too much from their mobilization functions. It receives the battalion commanders of the Engineers, Colonels and Generals of all arms, who are set problems on the organization of ground, destructions, reparations, inter-communications, crossing of water courses, etc., under war conditions such as will be faced by the Engineers or by the commanders called upon to employ them.

The Sapper should explain the possibilities and impossibilities before Commanders of other arms at the service of whom they will always be placed ; this is why he is christened in our Regulations by the somewhat pompous title of " technical adviser." The spirit of discussion, the fruits of work and logic, the defence of personal opinions, the give-and-take, does not always run smoothly. It is a force and it is a weakness ; a force with those who ask to be enlightened, a weakness with those who wish to be obeyed.

As a result of living modestly, rather apart, the Engineers end by

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being the only arm unknown in the Army, unknown even by their brother officers, on account of its variety and its complexity. Moreover, from its creation, the centre of tactical studies was immediately sought out. It thus contributed to the breaking down of water-tight compartments and the closer co-operation of different arms. It also receives foreign generals and colonels.

Finally, an advanced course for reserve officers of the Engineers of the Garrison of Paris has just been created at the School of Versailles, taking advantage of its cadres and its resources. The courses and exercises might be extended throughout France, thus permitting outside training.

THE CADRE.

We should be neglecting our duty if we did not say a few words on the Cadre which provides for these various needs. In conformity with the unbroken traditions of the Engineers, inculcated by Vauban and always maintained by his successors, the sapper never spares himself. The work which each one is called upon to carry out must be done: it is done here at the price of endless repetitions, caused by the number of divisions, with the different types of instruction involved in each one according to the scientific standard or the duration of the course.

Eight divisions in 1928, with distinct courses, represented heavy work for the Cadre. About 50 professors and instructors suffice for this task. Their task is indeed extraordinarily hard, and those of them who ensure annually 596 hours of courses, visits, or examinations —in ten working months—without counting correction of work, deserve our respect.

These instructors only remain a few years at the School, after which they either return to regimental duty or some other post. Moreover, each one perfects the courses of his predecessor, being content with merely adding the fruits of his own personal experience. Military work has the great honour of being impersonal and collective. These courses thus constantly polished up and repolished are kept well up-to-date with scientific progress and practical work, without exacting from the officers a work for which they are not always thoroughly trained.

Besides the six principal courses—construction, fortification, employment of weapons in combat, applied science, topography and geology, administration and public law—there are naturally also courses or classes which, although having smaller coefficients, are no less of great importance; modern languages (German, English and Arabic), physical exercises and equitation. For the T.O.E. (Foreign Theatres of War) where nearly all the officers of this arm serve—it is essential that the Engineer officer should know how to ride, carry out reconnaissances, and go through the shops, etc. The annual fête at the School is before all a sporting meeting, and the riding events

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of the Sappers are in no way behind the famous Tilting Yard of their artillery comrades at Fontainebleau, although lacking the incomparable background of the forest.

Finally, there is the real military part, that is to say the training for regimental duty, comprising a study of the regulations, the number and variety of which increases each day, even more in the Engineers than elsewhere on account of the complex requirements of modern armies which the Engineers have to satisfy; the Sapper is also obliged to learn the military regulations of other arms in addition to his own technical regulations.

Nearly all this part has to be absorbed in the first six months, since the young officer should be available for mobilization within this period. Some find this a bigger chunk than they can chew. This would be the case particularly for mathematical brains, who, to begin with, are not well prepared for such an effort of pure memory. Fortunately, however, practical exercises—navigation, bridging, destructions, mines, fortifications, telegraphy, various mechanical work, electricity—facilitates this assimilation, hardening and developing the physical body which has often suffered from want of an open-air life. These works are sporting and health giving. It is necessary to arrive at a good balance of brain, physical fitness and character; the brain, by the spirit of accuracy, method, clear-headedness; the physical, by the taste for endurance and physical exercise; the character, by cheerfulness, sense of humour, cultivation of will-power and smartness. Few words, orders, actions. To inspire a taste for action, a task well carried out rather than making a fetish of regulations.

This is essentially the mission of the military instructors, who, on principle, should not leave their "brigades" during the whole of the stay of the latter at the school. The rule is to be very strict with the junior ranks; give latitude, but never to be slack; harden the body and strengthen the character; the Army should be a school of discipline and energy. An increase of discipline is always interpreted by an increase of well-being, and the development of energy by a supplement of force.

Means of Instruction.

As means of instruction, the School has, besides its laboratories, collections, practice ranges, etc., unlimited resources from the industrial centres of Paris, the directors of whom afford every facility for officer students to visit their installations or factories.

They have also, from the military point of view, material from the two Engineer regiments at Versailles. The first Engineer regiment has both all the resources of an old regiment of sapper-miners as well as entirely new workshops amply fitted up quite recently by a battalion of electrical mechanics. The 5th Engineer Regiment of Rail-

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ways possesses considerable and very complete yards and docks, at the practice range *des Matelots*; thus the whole railway service can be studied on the spot and in traffic working.

Finally, the battalion of telegraphists of *Mont-Valérien, la Tour Eiffel*, the central establishment of military telegraphy, offers from this standpoint a special aspect of all the elements of instruction, and also gives the young men practical examples of the most recent progress in this branch, in which France has always been the pioneer, thanks to General Ferrié and his collaborators.

From the point of view of bridging alone, the absence of a river at Versailles, the limitation of the resources to a small branch of the Grand Canal of the park, might be disadvantageous, if two courses of a fortnight had not been arranged on the Moselle at Metz and on the Isère at Grenoble, at least for the principal divisions.

Finally, Versailles is a veritable military university where there is an air school, a tank school, a centre of infantry studies, a school for signals and intercommunication, etc.

In a school of this type personal work is naturally limited to the class work. However, at the end of the second year the officer students are called upon to produce, within an average limit of two months, studies of a more personal character, for instance a memorandum on the subject of fortifications, distinct for each one, or a study of permanent fortifications, where the variety of solutions prove that there still exists imagination in our youth, and the finish of the work shows the interest taken by the students.

Examinations at the end of the course are mostly taken away from the School, in the field, for everything of a specially military character, and only bears upon the class-work itself in the exclusively technical subjects.

Officer students pass out from this School "jacks of all trades" but masters of none. The intellectual knowledge given to an officer should permit him to start life and continue to advance along the ways which open up for him; he should not be an end in himself, upon which we can depend by just using him without improving him. The Army and the Engineers, perpetually evolving, have long ago absorbed these principles.

Historical Buildings.

As regards buildings, the School, which has been increased by a new division each year since 1923, has not been able to increase its accommodation in proportion. The result has been a certain disintegration; the divisions have been distributed over five different points at Versailles without counting the working or exercise grounds. The parent building, where the original Artillery and Engineer military school was situated, is nothing more than the old *Hôtel des bureaux de la guerre* constructed in 1759 on the old site of the royal

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kitchen garden under the Belle-Isle Ministry, by the Engineer Berthier, father of the Marshal; it was there that the future Major-General of Napoleon I, himself an engineer officer, was born. At the time of the visit of Louis XV, for its inauguration, the Engineer Berthier, with a view to proving to the King how fireproof this building was, lighted a large wood fire in the interior of a room; no fire resulted, and the King congratulated him. The monumental door, which is classed as an historic monument, is decorated with bas-reliefs, where may be seen fortress plans, gabions, cornucopias picturesquely pouring out officers' crosses and decorations, etc. The School is perpetuating the tradition. The crown which dominates the beautiful doorway in sculptured wood, between the two pillars surmounted by trophies, fortunately was not damaged by the Revolution. On the other hand, a decorative border in the Court, in which to-day the bust of Lazaire Carnot has been let in—an Engineer officer before he became the organizer of victory—has been deprived of its charming bronze panels which represented victories during the reign of Louis XV, as may be ascertained from contemporary engravings; the figure of Victory—modern—which, bending over, crowns the bust of the great Carnot, certainly cannot replace them.

This house is a neighbour—in the best sense of the word—of the former Ministry of Foreign Affairs, to-day a library of the town of Versailles and a most interesting museum on account of the value of the volumes, bindings and collections which are in it. The building is decorated with a splendid doorway and charming interior decorations.

The School was enlarged in 1922 by taking in an annexe in the same street, the former *Hôtel de la surintendence des bâtiments du Roi* (hotel of the department for royal buildings), which was inhabited by the great Mansart and which also served as a depot for the King's pictures, before it was transformed into a small seminary.

The annexes of the other military buildings have no architectural interest, but this cannot be said of the small stables, where the cavalry section of the School, its riding schools, its physical exercise ground, its Artillery museum and its Engineer museum, are accommodated. This forms a splendid *ensemble*, constituting a worthy setting for the Place d'Armes and the courtyard of the Château. Although devoid of decoration, there are undoubtedly no stables in the world to compare with them, solely on account of the perfect lines and art of their proportions; which has been rightly called the essence of architecture. Has ever chance been more providential than that which has thus placed under the eyes of the future military constructors such a model to inspire them with the art of making buildings beautiful without unnecessary decoration? It is well that these young men should absorb this truth so well expressed by Diderot:

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"There are no follies which last so long, are so marked, as those which are carried out in stone."

No doubt the Engineer officer would be glad to be relieved of this very thankless task of building barracks, where he is torn asunder between the conflicting requirements of limited resources and very extensive requirements, which keep him far from the command of troops, which is a far more agreeable life. The Minister for War is obviously the only minister who thus possesses his own Corps of Architects. The fact is that the designing of plans and the direction of the workshops is indispensable for the training of officers for their role in war and their service in peace in the colonies or in fortifications. The distinction between civil and military work is often subtle, and it is thus that each year our Engineer regiments carry out public work for the communes, roads, bridges, etc., or for the State, railways, telegraph lines and permanent fortifications, which contribute to their training whilst benefiting the general public. The immense system of 60-cm. railway lines in Morocco was planned, and worked, by the Engineers.* The sapper is before all a constructor and a producer.

How successful he has been, the forts of Verdun are a living witness. Whereas all the foreign works were pierced by German shell, our concrete of Douaumont and Vaux triumphantly defied the largest calibre of the two adversaries, thus affirming the victory, incontestable in the circumstances, of armour over guns.

FUTURE OF THE SCHOOL AND ITS INFLUENCE.

The Military School of Engineers, by developing amongst the officers of the Engineers which it has trained, the spirit of scientific research, initiative, the cult of military duty, even to the point of sacrifice, deserves well of the country. The above mention in Army Orders of 22nd May, 1922, confirmed the services rendered by the School of Versailles during the War.

Engineers have one sole advantage over the majority of the other arms, that is, that their studies and their work, touching almost every branch of applied science, construction, electricity, railways, is obliged to keep up-to-date. An advantage, it is true, but also a disadvantage, for the efficient officers are naturally attracted towards industry, which offers employment no doubt more exacting—despite what is thought—but better remunerated. Therefore, we should respect those who, possessing a great technical knowledge, resist these tempting offers—there are some, and not the least efficient—and follow

* The Engineers even have native units in Northern Africa, in the Soudan, and in the Far East. Far from the mother country, the sapper like all good Frenchmen becomes a politician: but it is railway politics. The result is colonization by steam. In our colonial empire, which is larger than Europe, in this greater France of nearly one hundred million inhabitants, the sapper, after having survived the epic of the war and victory, lays down his weapon to take up the tool. Work is his *raison d'être*, his life.

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the military hierarchy and contribute to maintain scientific men in the Army in accordance with its fine tradition.

Moreover, how wrong it would be to wish, as some have attempted, to divorce science from morale; science raises morale; the two complete each other and are not incompatible. Whatever capital importance faith and patriotism have, they do not suffice to level mountains, nor even to repulse the invader. Science and the art of war are still required. Science is represented by our technical arms; art is represented by the command and its staff; the task of the other executants is still sufficiently heavy for us to refuse to compare their merits. The contrary thesis becomes all the more false since all the arms to-day are more or less slaves to technical knowledge. The technical side creates the tactics; the tactical and moral requirements on the other hand impose the technical and material solutions. The two aspects of the problem are intimately connected. It would be a serious error to attempt to divorce one from the other.

The Engineer School fulfils its mission of silently training modest officers having a very high sense of duty and developing their technical knowledge every day of their lives. Devotion to duty is essential, particularly in an arm always called upon to serve others. "To render service" might very well be the device of the Engineers, if other arms were not tempted to rob it later.

Although the Engineers are the least known arm of our Army, it appears on the other hand that foreigners are deeply interested in our studies. The School has, in fact, veritable tentacles abroad; its printed courses are asked for everywhere, and constitute the most effective propaganda, whilst rendering service to our friends; its relations are kept up with Belgium, the Argentine Republic, Poland, Czecho-Slovakia, Roumania, Holland and even Italy.

Each year a few Polish, Roumanians, Esthonians, Finnish, Lithuanians, Greeks, Turks, Peruvians, Chilians, Mexicans, Persians—the latter as officer students, even wearing French uniform—come to receive the extra training and to learn to love France. Although generally older and more senior in rank, they live as good comrades with the young French officers, and the interchange of ideas which results is not the least mutual benefit. When they return to their country they are all warm supporters of French friendship and culture.

The Editor of the *Revue des Deux Mondes*, when kindly giving permission for the reproduction of this article, wrote as follows:—"Son auteur était le Général Normand qui, détail tragique, mourut trois jours après la publication de cet article, en tombant du train qui de Paris le ramenait à Versailles; le Général Normand, jeune encore, était directeur de l'Ecole du Génie dont il parle dans cet article."—EDITOR, *R.E. Journal*

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SURVEY IN RELATION TO GUNNERY PROBLEMS IN MOBILE WARFARE.

A Lecture delivered at the S.M.E., Chatham, on October 3rd, 1929, by COLONEL M. N. MACLEOD, D.S.O., M.C.

THOUGH in the title of my lecture Survey and Gunnery are given first place and Mobile Warfare comes last, I think it advisable to start on the tail by defining what I mean by mobile warfare, for there are some people who appear to think that the next war will be composed exclusively of encounter battles between forces travelling at well over the legal speed limit.

I must ask you to imagine my war as starting at the point when these law breakers have collided with one another and have been removed to hospital. The mobility I have in mind takes place principally between battles, and I assume that both sides will be prepared to devote a certain time to the prosaic tasks of finding and fixing the enemy before they commit themselves to the more spectacular work of hitting and being hit.

I propose to take up my tale at the end of the Great War, for the Great War saw very notable developments in the survey line, and when, after about three years of it, the gunner and the surveyor at last achieved a working alliance, they did great things. Indeed, I am prepared to demonstrate to anyone who will come round the corner afterwards that this alliance was the turning point of the War. I will spare you that now.

What I want to do this afternoon is to talk about the future of that alliance, and explain, if I can, what it means to the sapper (*i.e.*, the surveyor), what it means to the gunner, and finally, what it means to the rest of the Army, particularly to the infantry soldier.

Now, survey has always been a very important science to the soldier. Not for a long time past has an Army been able to function without maps. You probably know that it was military requirements which started the Ordnance Survey, and that the only man to whom Napoleon confided his plans was his chief topographer; both significant facts. Nevertheless, I think it is correct to say that the military authorities, at any rate in the past, have regarded the surveyor rather in the light of a necessary evil, a sort of hybrid, half civilian, half reservist, whose job was done entirely in peace-time,

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and who, if he went to war at all, should certainly be left at the Base.

At any rate, it is a fact that at the commencement of the Great War all available survey personnel, both officers and men, was immediately withdrawn from survey work and parcelled out to Field and Army Troops Companies, with the result that, as I said before, it took three years for the gunner and the surveyor to arrive at an understanding.

Some people seem to think that the survey developments which took place during the Great War are a normal attribute of siege warfare only, and that with a renewal of mobile conditions the old days will return. I shall try to show you why I think that this is not so, and that the war function of the surveyor was never more vital than it is to-day; that his work influences, or can be made to influence, tactics in a greater degree than ever before, for there have occurred recently, advances in survey technique, which, if we can make use of them, promise to have far-reaching effects on artillery action, and through it on tactical doctrine.

Let us first, then, note this doctrine; it is summed up in Sections 13 and 15, *F.S.R.*, 1924:

Section 13: "The duty of the infantry is to close with the enemy and destroy him."

Section 15: "The role of the artillery is to assist the other arms in breaking down opposition and to afford all possible support to the infantry, with whom the eventual decision rests."

In studying this doctrine, it may occur to some of you to enquire why it is that, although we possess weapons which will kill men, cut wire, blow in trenches, knock out tanks, etc., from miles away, *F.S.R.* still insists on the need for "closing with the enemy" and finds it necessary to say (Section XIII (3)) "fire alone will seldom drive determined troops out of their position." The explanation is, of course, that "fire alone" is not of much use unless it hits the enemy, and in the past it has not always done so. On the other hand, if it does hit the enemy, it will do better than "drive him out of his position": it will lay him dead in it.

When, as in defence, fire can be made to hit the enemy, it does all the destroying that is required. Indeed, the strength of the defensive, which is the outstanding feature of modern war, derives directly from the ability of the defender to do all his fighting by "fire alone," while he prevents his assailants from doing so by hiding himself in a hole in the ground.

It is only when he gets to close quarters that the attacker can compete with such an opponent on equal terms: hence the instructions to spare no effort in getting him there in the best possible fettle.

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In conformity with these instructions, we have found it necessary to try a great variety of tactical experiments: open formations, supporting fire, night operations, smoke screens, etc., and finally, tanks, all of which involve an ever-increasing complication, which makes the control of the forces on the battlefield more and more difficult.

There are few people, I think, who would claim that we have yet found, even in the tank, a completely satisfactory solution of this problem; so difficult is it, that one can observe a constant tendency to try and evade its most difficult phases by falling back on the vicious principle of trying to push in the attack by piling up numbers. Witness, for example, the diagrams in *Tank Training* showing four big, square tanks stalking one poor little anti-tank gun, or, again, the tendency to replace one big tank by several little ones, in the hopes of overwhelming the anti-tank defence by rush tactics and weight of numbers. The Great War showed very clearly that, against modern weapons, weight of numbers may be a broken reed and rush tactics mere suicide.

This principle may be all right for Continental nations, who think in terms of conscription and cannon fodder; let us be on our guard against it. In searching for an alternative, let us remember that this deadly close-quarter business would not be necessary at all if our shells and bullets could be made to hit the enemy; in short, before we consider any further complications in the mounting of an attack, let us look carefully into the question of hitting targets and see whether there may not have been defects in our former methods of doing so which made it necessary to send forward crowds of bayonet men to do work, some at least of which might have been done just as effectively by H.E. shells.

When we examine it in this light, we shall see that the pre-war procedure for guiding shells to their destination had some serious defects which made it particularly ineffective under mobile conditions. I think I am right in saying that the pre-war gunner expected to do most of his shooting over open sights, and that when, quite early in the War, he found himself compelled to give this up, he had to improvise a new procedure in rather a hurry.

In the first place, it was necessary for him to see the target, so that its range and direction could be measured: next, this range and direction, measured usually from an O.P., had to be transferred to the gun, which might be some distance away. This was done by a very rough-and-ready calculation and was only intended to be sufficiently accurate to ensure that the first round, when it was fired, would fall near enough to the target to enable it to be observed. If this result was achieved, a correction was passed to the battery, and the correct range and bearing were found by actual shooting, by a system of trial and error.

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You can see that if the target was so inconsiderate as to move during this process, it caused no little inconvenience to the battery commander; moreover, there was always the danger that " A " might mistake one of " B's " rounds for his and apply a correction which he might then try to confirm by one of " C's." You can well imagine how difficult it was to work a great concentration of artillery like that for the Battle of the Somme, when several hundred batteries were all trying to range in a limited area at the same time.

I doubt, however, if the mere difficulty of ranging is the worst objection to this system. However skilful the gunner may become in working it, he cannot prevent his target making off or going to ground long before the ranging is finished. To get the best results from artillery fire, particularly in mobile warfare, the very first rounds ought to take effect before the enemy can get away or under cover. In a well-regulated artillery attack, fire should commence not with a single round, but with a concentration, and the enemy should never have a chance to know what it was that hit him.

This is where the surveyor steps in, for the effectiveness of the surprise bombardment depends on three things.

(1) The exact range and direction of the " target " must be known.
(2) The gun must be laid in this direction with an accuracy commensurate with its performance.
(3) The prevailing meteorological conditions and their effect on the performance of the gun must be known.

The last is a gunnery matter with which I will not deal beyond saying that it is a problem definitely capable of solution, but the first two are essentially survey problems in which the chief thing to be considered is the standard of accuracy required.

Now, the 100 % zone of the field gun at ordinary ranges is an ellipse about 100 yards long and 10–20 yards wide. If the target is considered as a point and the elements are determined in such a way that they lead to greater errors of " laying " than this, no shell can possibly hit, however many rounds are fired. The shape of the zone shows also that errors in " line " (*i.e.*, direction) are much more destructive to the best performance of the piece than errors in range.

The determination of line and range reduces in practice to the determination of the positions and heights of gun and target and is complicated by the fact that the most important targets cannot generally be seen from the front at all; *e.g.*, hostile batteries, concealed machine guns, and columns of troops marching into position. As to the latter, obviously from the gunner's point of view the time to catch them is while they are in concentrated formation; troops make the best artillery " target " before they deploy and not after. This they always do behind cover, hence whether guns fire from tanks or from the ground (a point I shall come back to later), if the artillery

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want to kill the enemy and not merely support the infantry, it must attach special importance to *indirect* fire at targets which cannot normally be seen except from the air. How is such a target to be located within the limits of 20 yards or so given above ?*

I see only one way, and that is by aerial observation aided by a map on which the airmen can pinpoint the target accurately enough by direct reference to map detail. What sort of a map does this imply ? Will the 1" map which we use in England serve this purpose ? Certainly not ; because, apart from all questions of accuracy, it does not show enough detail to enable a target to be pinpointed in this way, and we cannot measure on it distances so small as 20 yards. The artillery are agreed that the smallest scale on which this sort of thing can be done is about 1/25,000, which is nearly three times as large.

Nor are things very different in respect to hostile batteries using indirect fire. I do not see how we can possibly attack these except on the basis of location from the air. In France, it is true, we made use of flash spotting and sound ranging for locating hostile batteries, and got good value from them, but flash spotting only functions at night, while both—more particularly sound ranging—are difficult to work in mobile warfare, and neither can fix the height of the target, which is one of the elements of the problem. Hence we are again brought back to a complete dependence on the map, for the airman, though he may be able to range a battery on to such a target, cannot give a location accurately enough for unranged fire except with the assistance of a detailed map.

Lastly, we come to the concealed machine-gun. This is *the* great conundrum which has exercised military minds for the last 15 years. How is the concealed machine-gun to be engaged ? Officially there are two main " solutions "—the " accompanying gun " and the " tank." I will deal with these in turn.

The idea of the first is that, if you can bring a gun up near the attacking infantry, it will act as a sort of " big brother " to them, and when the infantry are held up by machine-gun fire they can turn round and shout for help and " big brother " will somehow or other step forward and clear the way. Everyone who has tried to work out schemes involving " close support " of this kind knows that this solution fairly bristles with difficulties ; for one thing " big brother " in order to keep near the infantry at all has to become a very " little brother," and unless he is in a tank he has to halt and unlimber before he can fire, hence he must get left behind if the attack is to get on, and if he gets left behind, how is he to know what to shoot at next ?

* *N.B.*—It may be as well to state here that the gunner does not usually think in terms of anything less than a section of two guns, so that these limits of error may perhaps legitimately be doubled. This does not alter the fact that a small target like a machine gun will be missed by one or other of two guns laying down shells on a 40-yard front.

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When you work it out you always find that " close support " from any kind of gun involves :—

(1) location by the leading troops of the machine-gun which is holding them up ;
(2) passing this information back to " big brother " ; and
(3) effective action by " big brother."

If the target has to be pointed out and then ranged on or engaged by direct fire, one round of smoke in the right place will stop the whole performance, and one can see endless possibilities of difficulty, delay and failure. If, on the other hand, it can be located at all, the gun should be able to hit it more easily and more quickly from the comparative safety of the artillery zone further back. Moreover, in this case, support can be given by any or all available pieces without the same restrictions of size or ammunition expenditure.

Now, what about the " tank " ? Many people seem to think the tank provides a complete solution, at any rate on ground over which tanks can operate.

I think so, too, as long as it is only machine-guns against which the tank has to operate ; but if the enemy, as he certainly will, brings up anti-tank guns and hides them in the infantry position, then we are up against the old problem in a slightly different form, and instead of foot soldier *versus* machine gun we have tank *versus* anti-tank gun.

Bitter experience tells us that in this contest the foot soldier always comes off second best ; all he can do is to go to ground and call for " big brother." Analogy indicates that the tank will fare no better if as well, for though he moves faster he is bigger to hit, harder to hide, and cannot go to ground.

I think it is now generally conceded that against a properly organized defence the tank cannot hope to succeed without artillery support, but some optimists seem to think that this support can be given by artillery tanks trekking along close behind the infantry variety. I am afraid I am not one of them, because I think that the tactics of the defence will be to hold its fire until the tank attack is committed beyond recall, and that it will be able, owing to the more advantageous conditions under which it fires, to overwhelm attacking tanks before they can retaliate at all.

I notice in many recent writings on tank warfare (and not excepting official documents) that it is usually assumed that the tank will have a target to shoot at and will be able to return the fire aimed at it. I think this is asking a good deal. The whole difficulty in this matter, as I see it, is that the attacker, whether infantryman or tank, either never gets a clear target to shoot at (particularly if he has enveloped the position in smoke), or, if he can see the target, has to shoot at it

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himself with a flat-trajectory weapon which, as we know, has very little effect against well-entrenched troops.

The best " close support " against entrenched troops is that given by a high angle fire. This being the case, I do not see how satisfactory solutions of the " close support " problem can be found except on one or other of two bases—either the attack must go forward, as it did in France, under cover of a barrage, aimed at nothing in particular, or everything in general, whichever way you like to look at it, or else the attackers must discover some way of locating the positions of their opponents and of passing this information back, so that they can concentrate their available artillery fire on these places.

As to the barrage system, it has been tried in France, and it will work, and work well, if you have enough guns and ammunition, but it requires prodigious amounts of both, much of which is not only entirely wasted, but sometimes, as we know, actually creates spare defences and obstacles for the protection of the enemy. On the other hand, if you can locate the enemy correctly and can concentrate your fire on him, there should be far less waste of ammunition and should sometimes be no necessity to send the infantry against him at all, for a concentration of artillery, if sudden enough and accurate enough, will do all the " destroying " that is necessary.

Is it possible to locate the enemy well enough for this ? To answer this I feel inclined to quote the man who was asked if he could play the violin and replied, " I don't know, I have never tried." I can, however, say this, that the location of anything on the earth's surface is a survey problem, and if the surveyor can find a solution of this one, he has paved the way towards a tactic which seems to me to offer much greater chances of success than any which has yet been suggested, armour plate notwithstanding. In my opinion then the first step towards the solution of the " close support " problem is the provision of an accurate map, on which every relevant detail of the landscape is shown. We must not be content to show only roads, railways and the things we are at present accustomed to ; in many places they do not exist. We must, if necessary, add rocks, bushes and anything and everything sufficiently prominent and easily identifiable, so that the moment the enemy discloses his position by opening fire, he can be marked down by reference to the nearest feature shown on the map.

This I regard as the surveyor's first task—to provide the troops with a map, or maps, one of the functions of which is to enable targets to be located. I will now pass on to the assistance he can give in the matter of hitting these targets.

Assuming that the target has been successfully located, the next thing to do is to fix the gun. Unless we insist on pushing it up alongside the infantry and keeping it constantly on the move, this is relatively an easy matter. We may use a map here also, or, if not pressed

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for time, we may resect, traverse, or triangulate. Fixing the gun is a straightforward survey problem susceptible to a variety of solutions, of which a trained surveyor may be trusted to select that best suited to the circumstances of the case.

Knowing the position and heights of gun and target, the line and range can be calculated. This, again, is a straightforward business about which all I need say is that the calculation is simplified and much expedited if the positions are defined by plane rectangular co-ordinates; and that, as the application of plane co-ordinates on the curved surface of the earth is only permissible within certain limits and must be done in certain systematic ways, the surveyor who devises these ways and defines these limits must have an exact knowledge of the shape of this surface and of the methods of representing it on a flat plane. He is thus, much against his will, brought into contact with those thorny subjects, geodesy and map projections, which the ordinary R.E. officer views with such alarm and despondency.

Having then calculated line and range, the last step is to lay the gun in the required line. Here it is necessary to watch the accuracy rather closely. An angular error in pointing the gun of only 8′ will, at 5,000 yards, throw the 100 % zone (only 12 or so yards wide) right off the target, and although we may make some allowance for the burst of the shell, it is clearly preferable to get the target in the centre of the zone rather than on the edge of, or actually outside it. In practice we do not want to allow errors greater than 5′. The gun, as you probably know, is laid by means of a dial sight (a sort of crude theodolite, of which the gun forms the lower plate), and an aiming point. The gunner puts on the sight the angle between the bearing of the aiming point and the calculated bearing of the target and lays the telescope of the sight on the former.

The laying of the gun depends, therefore, on the correctness of the accepted bearing of the aiming point, and if the position assigned to the gun is used for calculating this, obviously the aiming point must be at least as far off, and preferably further off, than is the target, for any error in position will cause an error in bearing inversely proportional to the distance of the object.

Guns, however, are usually placed in valleys and places from which aiming points 5,000 or more yards distant cannot be seen. Hence the positional error which is permissible in fixing the gun must be kept out of the business of laying it, and we must give line in a different and more accurate way. This means, in practice, that the laying of the gun must be carried out on a trigonometrical rather than a graphical basis, and the second task of the surveyor is consequently to provide a trigonometrical control which will serve the double purposes of the map-maker and the gun-layer.

Having now explained what the surveyor has to do and what his

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work is for, I will go on to deal with some technical aspects of these tasks.

As my lecture has been concerned with gunnery, I have so far made no mention of what may be called the ordinary maps required to plan the campaign or to guide the army to the battlefield. These are old and well-recognized survey tasks which have lost none of their importance. The great area of theatres of war in which modern armies may have to operate compels us to use small scale maps for the manœuvre and march periods before battle is joined, and we have, therefore, to legislate for three distinct kinds of map:—

(*a*) Small scale for strategical and general use.
(*b*) Medium scale for march and manœuvre.
(*c*) Large scale for battle.

Maps of category (*a*) are required only by Commanders of units and formations and by the staff. A few sheets will cover the largest theatre of war. Category (*b*) must be issued more freely because, although it is used chiefly while troops are moving in formed bodies, it is necessary to allow for unforeseen deployment. Category (*c*) is only wanted for a stand-up fight.

This is where the new survey technique, which I referred to at the beginning of my lecture, comes in. Such maps are not to be found everywhere—indeed they are the exception rather than the rule—but thanks to the developments in aerial photographic surveying we can now undertake to produce what maps we require almost anywhere, in a time which definitely makes them a practical proposition in all cases where there is sufficient knowledge of the situation to get the area photographed from the air at least twelve hours in advance.

I have no time, nor, I think, is it necessary for me to go into any technical details here, but I must make a few remarks on the question of photography.

To map in the way I have mentioned, it is absolutely essential that the photographs should be taken vertically downwards in long straight flights with a uniform overlap and from a fixed height. As this type of flying is particularly liable to interruption and interference by enemy action and by weather, we would be very ill advised to wait until we have bumped into a position or arrived in any area before we did anything about getting it photographed.

It will have to be the business of the General Staff and the Royal Air Force to see that the photography is kept well ahead of immediate requirements. Once the area has been photographed in strips, there is no further necessity for this dangerous type of flying; defences and any other details which appear on the ground subsequently can be added very easily from any kind of air photo.

Air photography is, of course, only the data from which the map is afterwards prepared, and I think it well to remind you before leaving

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the subject that it is not a substitute for a map. An air photo shows neither heights nor contours, and is subject to a variety of distortions which may make it impossible to derive the required information from it without the aid of special apparatus and special training. In the hands of the inexpert man, the air photo without a map is nothing more than a snare and a delusion.

The preparation of maps is the job of the Field Survey Companies, R.E. Hitherto the map-maker has been given a pretty free hand in issuing to the troops whatever sort of map he thought best.

If my conjectures are correct and the soldier is going to use the map to help him mark down the enemy and fight him, it seems to me that the man who makes the maps must be in constant, close, and direct touch with the man who fights.

He has got to judge what can be done in the time available, for time will always be a limiting factor, what can be omitted without compromising methods of fighting, and what can be added to simplify and improve them.

He must work as close up to the front as circumstances permit, for not the least difficult of the problems he will have to solve is that of getting his products hot from the press up to the fighting line.

Remember that in war the face of the country changes very quickly and very often. A map may be out of date in some vital respect almost before it is printed. The type of map I have described, in particular, would require constant renewal, there is never going to be time to send it back even to the base to be printed; even from Army H.Q., where they will most probably be prepared, the problem of getting new editions out to the fighting line, where they are to be used, and preventing the old ones falling into the hands of the enemy (who would probably give a lot for them) is one which will only be solved with the intelligent co-operation of all ranks.

I do not anticipate any particular difficulty about producing the maps. Printing machines have been mounted in lorries, and it should be possible to design equipment which can be taken pretty well anywhere where a modern army can go and which could turn out maps at almost any desired rate.

Now as to the other half of the survey task, the provision of the trigonometrical control. Here again, we have a specialized problem. In civil practice, the triangulator can generally manage to reconnoitre his ground and to select and beacon his points before he starts observing. The military triangulator, on the other hand, has to try and fix his points, if he can, before he arrives on the ground. In a few cases the points may exist beforehand and he can do any additional work he requires by resection. More often he will have to fix points on ahead by observations from stations he has established himself. Sometimes he can perhaps get along by finding stations or erecting beacons so conspicuous that resection can be done from them for a

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considerable distance on ahead. Most frequently of all, perhaps, some gunners will arrive on the ground before him and will carry out small local surveys of their own, which he must connect up and incorporate as quickly as possible in the main triangulation system which he brings forward. All this will have to be done against the clock.

Time will not allow me to discuss the problem in detail. Admittedly, it is no easy one, but I see no reason to doubt that we shall be able to find a satisfactory solution.

Those, however, who think that the military surveyor of the future is going to be a gentleman who spends all his time in a comfortable office somewhere in the back areas, directing the efforts of a lot of C.3 draughtsmen, are sadly wide of the mark. The task of providing a trigonometrical control whenever it is required is likely to take the surveyor into the very forefront of battle, and as many people will be waiting for the results of his work without perhaps troubling to understand the details of it, I foresee that he will lead a strenuous life. This, of course, need not alarm us unduly, for it will certainly be an interesting one.

In conclusion, I would like to add a few more words on the tactical aspect of the surveyor's work, how I think it might be used to the best advantage in future, and some facts as to the results achieved by using it in the past.

I advocate, as you see, a survey-brand warfare in which, in attack, the artillery might be asked to take a direct and considerable share in the " destroying " of the enemy, and in which, at any rate at certain stages of the attack, the infantry might be asked to give " all possible support " to the artillery by trying to discover where the enemy is, by marking him down, and preventing him running away. In principle, the defence should first be " drawn " and then, with as little delay as possible, as much of it as can be located should be crushed by a concentration of artillery fire before it can move. The defence in its turn should be concerned to see that it does not disclose itself prematurely and should try to reserve its fire until it can be delivered with decisive effect. I imagine that the defender is quite safe as long as he lies 'doggo,' especially against tanks who use direct fire and can hardly carry enough ammunition to shoot up every likely hiding place on the chance of its holding a hostile gun. He can, moreover, when suitably armed, rely on stopping the fiercest unsupported rush, in quite a short distance.

I know that many people will say this kind of attack is a counsel of perfection. Experienced gunners will tell you that this is asking too much of the artillery. In reply to these I would like to say that you never know what you can do until you try. Hitherto, the gunner has not been asked to do more than support, and I have actually heard responsible artillery officers extolling the virtues of inaccuracy because of the " scatter-gun " effect thereby produced. If they are

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asked to get down seriously to the job of "destroying" the enemy, I believe it will be found that they can do far more than they now believe to be possible. I remember only five years ago how few senior R.A. officers would admit that artillery could be worked on a survey basis in any form of mobile warfare, yet after the last manœuvres the C.R.A. of the 3rd Division is reported to have described the artillery survey work done there as the greatest advance in the employment of artillery for three generations. If he can say that of tactics based on a distinctly shaky technical foundation, I don't think we should despair too soon of the results which can be achieved when the technical foundation is well and truly laid. My own opinion is that the artillery attack, if we can deliver it in the form of very sudden, very accurate, and very intense concentrations, coming as it will from an unseen foe, will prove more destructive and infinitely more demoralizing than the fiercest and fastest charge of cavalry, infantry, or tanks, that we can hope to deliver under modern conditions.

I do not say that it is going to be easy to operate in this way, there are a whole host of problems to be worked out and difficulties, both technical and other, to be overcome which I have not time to discuss here. It is with the technical problems that the Corps is primarily concerned. It is on the skill with which the technical foundation is laid that the success or otherwise of the tactical superstructure will depend, and I suggest that the problems I have described are worthy of the best brains we can give to them.

In essentials, the tactics I have outlined are little more than an extension of those used with such uniform success during the concluding stages of the Great War. Compare, for example, the Somme or Passchendaele, with their fearful losses and insignificant gains, when the artillery bombardment was designed only to clear the way for an infantry rush, with an operation such as that of the 8th August, 1918, when the whole attack was built up round a surprise artillery barrage based on maps and surveys.

Let me, however, end with a word of caution. The survey we have to develop is a specialized science, adapted and again adapted to the changing requirements and conditions of warfare. The military surveyor, if he is to make good, must, I think more than almost any branch of the Corps, keep in the closest touch with both the military and technical aspects of his calling. He must, in short, be a first class surveyor and a first class soldier. How to ensure this is beyond the scope of this lecture, but if I cannot promise that all of you young officers here who may be attracted to the survey line of business will finally end your careers as Generals, I can at least promise that you will find it a subject of absorbing interest and of high and increasing military value.

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A SUGGESTION BASED ON THE OFFICIAL HANDBOOK ON MECHANIZATION.

By BT. LIEUT.-COLONEL G. LE Q. MARTEL, D.S.O., M.C., *p.s.c.*, R.E.

THE handbook on mechanization which has recently been issued has been welcomed by everyone. It contains much valuable data on mechanization generally and provides a common basis for discussion; at the same time, it is in no way dictatorial, and leaves many aspects of the case open. It is therefore proposed in these notes to give the outline of a suggestion for an ideal small professional army, of the type which we might be able to afford and construct in perhaps five years' time and use in most parts of the world. It is based on this book, but as many of the vehicles referred to are only in a very early stage of development, some minor deviations are made in their organization and the work which they are considered capable of.

We will take the case of an army consisting of three infantry divisions and one cavalry division and some Corps or Army Troops, and we will make the following assumptions as regards their organization and the capabilities of their mechanical vehicles.

The first assumption is that the armoured machine-gun carrier is a vehicle with armour in front capable of resisting any S.A.A. armour-piercing bullets, and that the side armour will resist them up to 45° angle of impact. The machine is low and inconspicuous and capable of traversing any natural country with ordinary ditches and hedges, and has a maximum speed of ten miles an hour. As it is short, it is not steady enough to produce accurate fire on the move, but it can sprinkle the ground in front, and can halt momentarily behind any small mound or in a depression, and produce accurate machine-gun fire. It does not possess a revolving turret for all-round fire, but it can fire 15° on either side of straight ahead with its Vickers machine-gun, and it is a comparatively cheap machine, made largely from commercial parts, and can be replaced in war fairly quickly. It has a crew of two, and the remainder of the machine-gun crew march in rear. It is assumed that these armoured carriers, when used in sections of four, can definitely assault enemy machine-guns in open or semi-open warfare, assisted, of course, by the usual covering fire. Each infantry battalion possesses sixteen of these carriers, and in defence some of these guns can be dismounted and used on the ground, keeping the remainder mounted for use with counter attacks. The dismounted guns would be joined by the remainder of the machine-gun crew, and in the case of the mounted

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guns the spare numbers in the crew would serve as reliefs and to assist at times in mechanical maintenance.

The second assumption is that of the three divisions, one division has its first line transport entirely mechanized and all men who normally march are carried in lorries. This division has one light tank battalion as divisional cavalry.

The third assumption is that the cavalry division consists of two light armoured brigades and one cavalry brigade. The light armoured brigade consists of three light tank battalions, each with its 50 light tanks. As opposed to the armoured carrier, the light tank has a maximum speed of 30 miles an hour, it has a revolving turret containing one Vickers machine-gun, and can shoot more steadily on the move. It is assumed that it has a crew of two and is proof at all ranges in front from S.A.A. armour-piercing bullets and proof on the sides from the same bullet at anything except short-range normal impact. As regards artillery, each light armoured brigade has 24 close support tanks, organized in a suitable unit. These take the form of 3-pounder guns mounted on a track vehicle and provided with a shield giving the same protection from the front and flanks as the light tank. It can thus advance and give very close support to the light tanks. The Cavalry Brigade is normal, but is supported by a mechanized 3·7-inch howitzer battery. The cavalry divisional troops include a brigade of mechanized field artillery and a mechanized field squadron R.E., and an armoured cavalry regiment.

The Corps or Army Troops contain two medium tank battalions, and also medium and heavy artillery.

We thus have an army organized in a simple manner into three types of formation. The cavalry division form the mobile troops, corresponding to the light cavalry in the past. The remainder are combat troops, but, of these, one division is mechanized so that it has at least double the mobility of a normal formation, and as it is in addition just as capable of hard hitting as a normal formation, it may be compared in some degree to the heavy cavalry who were used for the main flank attack in the past. Lastly, there are the army troops in the form of medium tank battalions and heavy artillery, which are not required in the opening phases of the war. We can now consider the employment of this army in a normal form of warfare.

The mobile troops advance to obtain touch with the enemy, sending armoured cars a long way ahead for this purpose, and working in co-operation with the air force. The enemy may be advancing in two, three, or more columns, and on his dispositions will depend the dispositions of our cavalry division. As information comes in, the commander forms his plan. He may decide to hold off one column while he strikes another column, but whatever plan he forms he must keep two points in mind. The first is that the light armoured brigades in the cavalry division are capable of controlling the enemy

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to a considerable extent, and making him conform to his wishes, but only if the ground is suitable to their employment. The second point is that he must endeavour so to control the operations that the main battle occurs on ground that is suitable to himself, or he will obtain little value from his mechanical vehicles when the combat troops meet. We will assume that one particular column of the enemy is advancing in strength, and that one light brigade is detailed to delay the advance of that column in order that our combat troops may meet it in the most favourable manner, and further that the brigade is instructed to weaken and harass this enemy column as far as possible. This task should not have been given to a light armoured brigade if the ground is very broken or densely wooded, but if the ground is at all suitable no task would be more suitable. On the march, the main column is defenceless against sudden attacks by light tanks. Hence they will have to put out flank guards, as well as advance guards and rear guards, and they will have to move from position to position, because they are also comparatively defenceless on the move. Hence the speed of the column will be at least halved, and the provision of so many protective troops is most exhausting. In addition, if the enemy leaves an important point such as a bridge on his line of communications unguarded or insufficiently guarded, it is a simple matter for a unit such as a light tank company accompanied by some sappers to destroy this bridge. Hence the enemy will have to leave many detachments to guard these points. There is, therefore, every chance that the commander will be able to use his cavalry division to control the advance of the enemy columns so that they conform to his plan, and that one or more main columns may arrive partially exhausted and denuded of many valuable detachments, and that the main battle will take place on ground suitable to himself. To carry out this work, little more than light tanks are needed on ground that is suitable to their use; they do not need to be accompanied by very much artillery, because their policy will be to avoid striking the enemy at a point where he has taken up a position and established his anti-tank weapons in defence. If the enemy does not do this, but continues on the march, he can be safely attacked; if he does do this, the light brigade have achieved their result by the delay that they have caused, and there should be plenty of opportunities for short, sharp, but decisive actions by the light tanks against weak detachments or columns, unless the enemy definitely stops and refuses to move, and thus loses all initiative.

This action on the part of the light brigades would, however, produce counter-action on the part of the enemy, and although—as will be shown later—it is far easier for us to produce armoured forces than a nation with a conscript army, yet they would certainly produce something in the nature of mobile armoured anti-tank weapons. Hence the light brigades require the close support tanks

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with their shielded 3-pr. guns. These machines would not be capable of assaulting in and among the enemy by themselves like medium tanks, but this does not appear to be necessary in this case; they could, however, follow immediately behind the light tanks and deal with any enemy tanks that appeared in small numbers, or with armoured anti-tank weapons; the light tanks can protect themselves against everything else in this type of work.

So far, we have considered the action of the mobile troops ahead of the main bodies or combat troops, and we have seen that their action may have a decisive result on the course of the campaign. We will now consider the action when the combat troops meet in battle. Our combat troops may have advanced in two or three or more columns; they may have been directed on one or more main enemy columns, but it is suggested that the same principle for the employment of the combat troops applies in each case, if the maximum value is to be obtained from the mechanical vehicles. In the first place, there may be a temptation to send the mobile portion of the combat troops (the mechanized division) on ahead to strike the enemy ahead of the main body. Although this might be very effective under some circumstances, it is suggested that this is wrong in principle; there is little value in giving the enemy a hard but indecisive blow if the main body is too far away to profit by the result. Hence the commander should keep this mobile portion of his combat troops in hand; they should march either on the flank or in rear of the columns of the normal formations. The first stage is, therefore, the contact between the infantry in the normal formations and the enemy combat troops, and the commander must endeavour to close with the enemy and pin him to the ground under conditions suitable to himself. The main point is that the ground on one flank or the other must be suitable for the delivery of a sudden attack by the mobile portion of the combat troops. The second stage is, therefore, the launching of the mechanized infantry formation on this turning movement. As their lorries are unarmoured they require protection during this movement, and this is provided by the light tank battalion belonging to this division or a portion of this battalion. These troops cannot move under these conditions with great rapidity; the necessity for providing for their protection takes time, and they have to dismount from their lorries and deploy some way back from the front, but they can nevertheless accomplish this movement two or three times as fast as a normal formation.

Wider still on the flank comes the cavalry division or a portion of this division. Some of them have already been in contact with the enemy during his advance. They now take part in this turning movement on the outer flank. If they strike a flank which is weakly held, they advance and so assist the advance of the mechanized infantry. If they find the flank securely held, they go further round. The enemy cannot possibly allow these mobile troops to go right

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round and attack his gun positions from the rear, and will be forced to extend his flank, and this at the same time as he is being hard pressed by the normal formations in front and the mechanized infantry in flank. But there are limits to the extent to which he can extend his flank, which will eventually break, and he will be overrun or forced to withdraw, pursued by the mobile troops.

Finally, we come to the stage where the enemy has had time to prepare fairly elaborate defences, and has secured his flanks in some manner. This case is fully dealt with in existing manuals, and needs little alteration as the result of the recent developments and thought. The light tanks would probably be unable to cross the obstacles, which would have been created by the enemy, and the medium tanks come into their own and lead the assault. If our reasoning has been correct, it may be that few or none of these medium tanks will have been required up to this stage, and that the medium tank can be kept back and brought up like heavy artillery for the main battle only. If this proves to be the case, it will solve many administrative and mechanical problems connected with these machines.

The above is a very brief outline of a simple organization which might reasonably be expected to work as indicated. It is in no way intended as the final solution at which we should aim in the more distant future; in fact, the mechanical vehicles which are proposed are all within sight, although some of them need several years for development. The proposals as regards the mobile troops are not particularly controversial, but there are many alternatives as to the way in which mechanized vehicles can assist the combat troops, when the main armies first come to grips. A medium armoured brigade which consists essentially of two light tank battalions and one medium tank battalion could have been used instead of the mechanized infantry on the flanks. It is likely, however, that the enemy will secure his flanks as far as possible with anti-tank weapons, and he may have these in considerable numbers. Tanks and especially medium tanks are very expensive, and will not be easily replaced in the early stages of a war. It is true that the medium tank is a less unsteady gun platform, and can produce a considerable volume of fire, but the control of this fire among the smoke, noise and uncertainty which exists in the front line presents many difficulties. Hence, there will be an inclination to let these more mobile arms seek the extremities of the flanks and work round, rather than assault the positions where anti-tank weapons exist. For this work light tanks alone are sufficient, and we used over-mobile troops for this work, backing up the light tanks by a close support gun, which is a much less elaborate and expensive vehicle than the medium tank. If one is looking further ahead than the present or immediate future, it would seem that there may be more scope for an increased number of improved armoured machine-gun carriers as the substitute for the mechanized infantry used as the flank attack. They may have heavy

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armour in front and protect their flanks by manœuvre and fire, and if used in large numbers on suitable ground it will take a very good anti-tank defence to resist them; these views have already been expressed by the author in several journals some years ago, but they dealt with the future, while we are now dealing with the present or immediate future.

In all these discussions the case has been considered more from the point of view of our army possessing a reasonable proportion of these fighting vehicles against an enemy possessing fewer of them and few or no armoured formations. This is reasonable enough, as there is little chance of our meeting such opposition in our small wars, and any conscript army that we might meet in a great war is very handicapped compared with ourselves in the production of armoured formations. With us, we can create very large savings by comparatively small reductions in strength, because our pay bill is a large one, and it is largely by this means that we have been able to make such headway in the production and provision of these mechanical vehicles. Not so with a conscript army.

The supply problem is one that has not so far been referred to, and it is too big a problem to enter into here in any detail. That there are considerable administrative difficulties connected with the use of armoured fighting vehicles is obvious; it is possible, however, that we may find the supply problem less serious than it appears to be at first sight. The most alarming figures were produced for the requirements of the old armoured force, and this gave rise to the idea that the supply problem alone would throttle any extension to the mobility of armoured forces. It should, however, be remembered that this armoured force was a mixture of combat troops and mobile troops, and that the combat troops, which should not form part of the mobile troops at all, consumed over three-quarters of the petrol required by the force. A medium tank will probably be found to consume six times as much petrol and oil as a light tank. If, therefore, we restrict the mobile troops to the lighter type of fighting vehicle, the supply problem assumes reasonable proportions. For instance, four 30-cwt. lorries will probably be found sufficient to carry the petrol and oil required by a light tank battalion for 100 miles. The heavy types such as the medium tanks require considerable supplies of every kind, but if they are marching with or near the main bodies the problem of supply is not so difficult.

In conclusion, the author would like to make it clear that no part of this paper is written in a spirit of criticism. The subject is one in which no one can see more than a very short distance ahead. In any case, when it is remembered that we were the first army to produce an armoured force for trial, and are again the first army to be in a position to produce a practical handbook based partly on field trials, there is little room for criticism, and this advanced state of progress appears likely to continue for many years.

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THE MECHANICS OF "MECHANIZATION."

By VICTOR WALLACE GERMAINS.

"The War has proved that an adequate provision of fire-power is the best antidote to heavy casualty lists."—MAJOR BROOK, "Evolution of Artillery in the Great War," *R.A. Journal*, Jan., 1929.

"The best protection against the enemy's fire is the fire of our own guns."—FARRAGUT.

THE mechanization of our Army continues to excite popular interest and enthusiasm, but the mechanics of the problem are too often lost to sight. The power developed by an engine is no more *unlimited* than is the muscle-power of men or horses; there enter considerations as to the ratio of horse-power to weight, of fuel-consumption to energy produced, and of the transmission of energy into work done. In its fundament it is an engineer's problem, but it is more than an engineer's problem, for such factors as terrain, the interaction of arms and services, must be taken into account. Thus it is a problem which is complex and many-sided, which calls for team-work between the soldier and the engineer, and one must be cautious as to how one accepts hasty generalizations of the type popular in the Press.

What is popularly termed mechanization is in reality *vehicularization*. The essence of the thing is the mechanically-propelled vehicle. The gun, rifle, or machine-gun are all just as much machines as the armoured car or tank. And in the strategic sense vehicularization is not new, but very old. Apart from the classic instance of Napoleon, who in his campaign of 1814 mounted infantry on carts to get increased mobility, the use of railways and road-lorries for supply-services and strategic movement was well understood before 1914; armoured trains and armoured cars represented a tactical application of *vehicularization*. The use of wagon-laagers by John Ziska in the Hussite Wars, and by settlers in the Western States of U.S.A., against attacks by Indians, are familiar to every schoolboy. Similar instances occurred in S. Africa. The classical chariot with its scythe-armed wheels was a very early development of the cross-country fighting vehicle, and must have been an awkward antagonist for infantry armed with bows and arrows, spears or slings. The mechanically-propelled cross-country fighting vehicle is a modern development of a very old principle, and fire in movement whether from chariots, Kentucky rangers at the Battle of the Thames in the

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war of 1812, or by Boer mounted riflemen, has been used successfully in many periods of history.

"Mechanization" at the present time may be divided into two headings. *strategic* and *tactical*. The first is a matter mainly of rapid transport of troops, guns and stores by means of motor-lorries or motor-traction, and includes supply services for an army. The second is a matter of the *fighting vehicle* in the form of armoured cars, tanks, or self-propelled guns. Here again we must distinguish between what are primarily road vehicles and those which are primarily cross-country vehicles. All vehicles use roads for approach-marches, but the armoured car, except under limited conditions, is tied down to roads; the tank, however, possesses the power to manœuvre off the roads, save when she encounters forests, deep streams, swamps, hills, etc. Thus even the tank is limited to favourable terrain, and the armoured car even more so.

Between tank proper and armoured car proper we have various compromise types; semi-tracked vehicles, six-wheelers, etc., but these all suffer, in a more or less degree, from being neither flesh, fowl nor good red herring. The semi-tracked vehicle has neither the mobility across country of the genuine tank nor the speed of the genuine armoured car. The six-wheeler, perhaps the most successful "compromise" produced to-day, has not alone a very limited efficiency "across country," but the pneumatic tyres can be riddled even by an ordinary infantry rifle. Various experiments are being made to overcome this: mail-shirting, self-filling or semi-solid tyres, etc. It is, however, so easy to devise a bullet to counter *any* form of protection that the tyres will always remain a vulnerable element in such cars.

"Mechanization" is at present in a very fluid state; there is such a medley of types of vehicles, and these are all so obviously destined quickly to be superseded that it would be profitless to discuss them. It seems wiser to confine ourselves to certain problems common to all and which are likely to present permanent factors. Whatever the distinction in design and purpose between *Lord Nelson*, *Mauretania*, the tramp steamer, the light cruiser and the destroyer, they have this in common, that they are all *ships*; their designers must all calculate in terms of "hogging," "sagging," metracentric height, etc., etc.; their principal job was in all cases to produce a thing which could *float*; the speed in knots, the thickness of armour—if any—the freight space available, the strength-factors involved in providing recoil-platforms for guns, depend upon the *purpose* of the ship and are a matter, fundamentally, of *distribution* of a sum total of weights available. Moreover, in naval design we observe certain factors of permanence which have endured over the entire period of armoured, mechanically propelled ships. When *Warrior* was designed in 1859 her designer must not alone produce a ship which could *float*; he must arrange for the most efficient and economical distribution of

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weights among armour, armament, engine-power, fuel, provisions. Given the limitation in general weights due to the size of the ship, any increase in the one element must be purchased by sacrifices in others; thus the design when completed was a compromise. When *Rodney* was designed 62 years later, the problem was still to produce a ship which could float and still to distribute a sum total of weight available among conflicting claims for armament, armour, speed, endurance (fuel and munitions supplies, etc.). A period of experiment and research exceeding half a century and costing vast sums of money had not affected the basic elements of warship design; the only practical result was to render the problem much more complex, for meanwhile there had been introduced mines, torpedoes, air-bombing, etc., while the recoil-strains involved in the firing of *Rodney's* 16-in. guns would have made *Warrior's* designer's hair stand on end.

The basic distinction between tank and armoured car is the distribution of the weight of the vehicle over a very broad bearing surface—the caterpillar tracks—instead of this being carried on wheel-points. The tank *floats* on a raft-like body, and if we observe the deep impressions left on the soft ground we are struck by the fact that there even applies, in a very limited sense, the principle of displacement. The armoured car does not *float*, her wheel-points are borne by an artificially-hardened surface, the road, and her capacity to move across country depends upon whether the soil is naturally strong enough to support her wheel-points. If this is the case, she is much more mobile than the tank. This happens, however, very rarely.

The tank is not a land-*ship* but a land-*raft*, and she suffers in comparison with the ship proper very serious disadvantages which, being inherent in her design, are unlikely to be materially affected by future developments. The power of her engines is applied *via* wheels to a very large number of bearing surfaces, the *shoes* of her tracks, and the loss in efficiency is immense. Every engineer knows what happens if you give a ship a very large number of small paddlewheels instead of two big ones. This is very analogous to what happens with the tank. In the Mark I tank, a 105 h.p. Daimler motor achieved with difficulty a speed of 3·7 miles per hour. The same engine applied to an armoured car over roads would have meant a speed ten times as great. Since then enormous strides have been made in developing the efficiency of the track, but engine-power for engine-power, mechanical efficiency measured against mechanical efficiency, surface for surface, the track cannot be anything like a fair match for the wheel. To this comes the element of friction involved in dragging a length of track over hard surfaces. The tracks very soon get worn out, even when moving at a moderate speed. One does not quite see how this difficulty can be overcome save by building the tracks of some material lighter and stronger than any we know to-day. The

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exposure of the tank's tracks, not alone to enemy fire but to dust and dirt, will be patent to every observer. Incessant cleaning is required. Here again one observes the defect without being able to suggest any remedy.

It is the custom to put forward some very misleading analogies between tanks and ships, but to argue that because war at sea has produced *Super-Dreadnoughts*, therefore war on land will produce a *Super-Dreadnought* tank is about as logical as to reason that because a carrot and a potato are both vegetables, therefore a turnip is a cauliflower. Conditions on land and by sea are fundamentally different. The editor of a very well-known Service journal* declares, "It is clear, however, that if the development of the tank is really to be a contest between the anti-tank gun and the tank's armour, the weight of the gun or firearm must be increased, and that at a very early stage in this development the firearm will become too heavy for the infantry soldier to carry or to handle in action." The statement scarcely shows adequate knowledge of the mechanics of this problem. It was the relatively free hand possessed by the naval designer in increasing the *size* of his ship, and in concentrating armour upon *vitals* which was truly responsible for the rapid increase in the size and power of ship's guns.† We have, for instance, a jump in dimensions from 2,162 tons in *Victory* through 9,210 tons in *Warrior* to 41,200 tons in *Hood*. The limitations on the size of the tank due to the necessity of being able to use roads, railroads, and bridges for approach marches, however, render a parallel development on land out of the question; nor can the tank-designer apply the principle of concentration on *vitals* to anything like the same extent. The entire tank is raised up above the land and exposed to fire. The duel, therefore, between tank-armour and anti-tank gun is thus limited on both sides by considerations as to weight-carrying: on the side of the tank to the maximum size which will not entail loss of strategic mobility, *i.e.*, power to use existing railroads, roads and bridges: on the side of the anti-tank gun to the maximum weight of weapon which can be handled in action by a man or two men. In this connection, however, it must be remembered that the tendency for the last ninety years has

* *Army Quarterly*, 1928.

† The 68-pdr. smoothbore was succeeded by the 6½-ton M.R. This increase of weight, 35%, led to the introduction of the "belt and battery" ironclad. To increase the weight and power of the gun is, from the mechanical standpoint, a much simpler business than to increase the weight of armour. *Alexandra* (1874) had 25-ton guns, roughly speaking a five-fold increase on the weight of the heaviest gun on *Warrior*, but, despite developments in engines, a two-fold increase in the general weight of armour was all that could be achieved without the sacrifice of other elements. Thus to get a thickness of 12 in. meant a reduction of the *area* armoured. The problem to be solved by the tank-designer is, however, infinitely more onerous than that of the armoured ship, and to produce an unarmoured *gun*—whether tractor-drawn or self-propelled—capable of piercing tank armour, will always be, from the mechanical aspect, cheaper and simpler than to produce a tank armoured to resist it. Any development of tank armour aimed at rendering the tank invulnerable to improved infantry weapons—by reducing the speed and "circuit" of the tank—would render her increasedly vulnerable to artillery.

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been for all classes alike of ordnance and of small arms to become immensely more powerful proportionately to the weight of the piece. The modern equivalent, for instance, to the 68-pdr. ninety-five hundredweight, smooth-bore guns of *Warrior* would be a 5-in. quick-firing gun, and in range, smashing-power and rapidity of fire the modern weapon can beat the older one hollow. To say that the 5-in. quick-firer could riddle the 4½-in. wrought-iron plates invulnerable to the 68-pdr. of 1859 is to put it very mildly. Such a weapon can pierce at close range more than its own calibre-thickness of the best modern armour. Other naval calibres such as the 16-in., 15-in., and 13·5-in. gun show the same tendency in even more marked degree. This also applies to infantry firearms. Brown Bess of 1803 weighed 11 lb. 4 oz., had a calibre of ·753 in., and with a bullet weighing 490 gr. had an effective range of 200 yd. A well-trained man could fire three shots per minute. The Short Lee Enfield of 1903 weighs only 8 lb. 2¼ oz., has a range of 2,800 yd., fires a bullet 215 gr., and sixty aimed shots can be fired a minute. Nobody can "scientifically" predict the development of weapons ten or twenty years hence, but it is wise to remember that the rate of acceleration now compresses into a decade a process of evolution which previously required a century; thus if we are to surmise the effect which the development of the tank is likely to have on infantry rifles and machine-guns, one would need to state an equation something thus:

Brown Bess : Short Lee Enfield : : Short Lee Enfield : Rifle *x*

On this showing Rifle *x* will range perhaps 20,000 yards, penetrate 3·4 inches steel up to 1,000 yards, reach an aeroplane at 10,000 feet, and fire perhaps 10 to 20 times as fast as any present weapon.

Many people will proclaim such a weapon to be fantastic: one can only say that all accounts of experiments on the Continent show a steady movement in this direction. The real range of the German Mauser exceeded 4,000 yards, although it was not sighted for this range: muzzle velocities have now been achieved double and triple those of pre-war days, and we are still only in the infancy of this development. If it was possible to make the tremendous stride in velocity from Brown Bess to Short Lee Enfield, whilst not alone lightening the weapon but reducing the effect of the recoil upon the shoulder of the man firing the piece, it is not quite clear why we should expect this process suddenly to cease because some of our staff officers have chosen to see in the tank a means of enabling our tiny army to achieve against Continental armies such as the French or Italian, feats analogous to those of Alexander against Persian "hordes," or the semi-legendary exploits of Sabutai. To double the muzzle-velocity of the bullet is to quadruple its smashing-power. Thus with the prospect in the near future of rifles with five-fold the muzzle-velocities of 1918 we have the pleasing prospect that tanks will need 4-in. to 6-in. armour against them.

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A very important point, but one which some of our staff officers, in their enthusiasm for the exploits of the Mongols, are apt to overlook, is the extent to which the Continental tank designer can "save" owing to the fact that his tank is supported on the one hand by numerous infantry: on the other by a powerful artillery. Armour against hostile infantry is, after all, for him somewhat superfluous: he has his own infantry to deal with these: his powerful artillery should deal with anti-tank weapons. What *he* needs is thus speed to cross the fire-swept danger zone, guns heavy enough to knock out enemy tanks, endurance to carry on through long periods of fighting. To gain in these qualities he can afford to sacrifice many others which the British tank-designer considers essential. The same thing applies, of course, to Continental infantry and artillery. If British infantry be eliminated or very greatly reduced, Continental infantry can equip themselves mainly for fighting British tanks: Continental self-propelled guns would find armour superfluous. At short range any armour would be riddled by machine-guns firing A.P. bullets, but for the gunner to engage the tank at close range is to throw away all the advantages due to the superior range and smashing-power of his piece.

The unfortunate tendency of the British Army to-day to use "Mechanization" and "Armoured Warfare" as synonymous terms obscures the vital truth that the two things are in reality quite different.

The attached tables of the depth of penetration of armour-plate by anti-tank guns of various calibres, taken from the *Militär-Wochenblatt* of Sept. 25th, 1928, although somewhat out of date, makes significant reading. One observes that a 20-mm. machine-gun (·8 in.) firing a projectile slightly exceeding 5 oz. in weight, can pierce close on 2-in. steel at close range, and, if it gets a direct hit, can pierce 1½-in. plates at 500 yards. Such a gun can riddle light tanks at 1,000 yards, and armoured cars up to 1,500 yards. With steel of exceptionally good quality, or if the bullet strikes at an angle, the penetration might be less, but when one thinks of the infinitesimal weight and cost of a ·8-in. gun and the relatively enormous weight and cost needed to produce a tank efficiently armoured against it, the prospects for "armoured warfare" pass under a cloud. An armour plate of 1 square metre in surface, 1 mm. in depth, weighs 8 kg. = 18 lb.; if 22 mm. in depth the weight increases to 175 kg.; and armour plate of this thickness with a surface 2 metres x 2 metres x 3 metres weighs six tons, minus stays, bolts, etc. A tank efficiently armoured "all over" even with 20-mm. steel would weigh some 24 tons, and such a tank will still be vulnerable at very long range; to armour her "all round" with 37-mm. steel, plus the necessary factors of speed, armament and endurance would increase the total weight to some 80 tons. A ·8-in. machine-gun could still pierce this armour at 100 yards; a 1.8-in. gun could do this even at 1,000 yards. One is forced to the

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conclusion that, as the mechanics of the problem suggest, even at first glance, there is happening on land, but even more rapidly and on an enhanced scale, what has already happened at sea: viz., the gun has beaten armour. When *Warrior* was designed in 1859, 4½-in. wrought iron could beat any gun afloat; *Monitor* and *Merrimac* battered one another for a very long period with their guns almost touching. But neither ship could damage the other, the action was indecisive, *Merrimac* was destroyed by her own crew to save her from falling into the hands of the Northern Army, *Monitor* foundered at sea. The action impressed popular imagination, but was in reality much ado about nothing, for *Merrimac* lacked the sea-going qualities needed to be truly dangerous to Northern shipping; the Federal ships she destroyed were at anchor in smooth water. Armour once introduced, however, there followed a tremendous development in rifled guns. *Alexandra*, designed some fourteen years after *Warrior*, had 12-in. iron armour; *Inflexible*, a few years later, had 24-in. plates, and our latest battleships, *Rodney* and *Lord Nelson*, have 14 in. to 16 in. of chemically-hardened steel. Even this thickness is vulnerable to an enemy 16-in. gun at 10,000 yards; for such a weapon point-blank range.

Given the much more onerous conditions under which the tank designer tackles his job, the triumph of the gun is bound to occur much earlier and to be much more signal. The extent to which the tonnage restrictions of the Washington Conference have revolutionized naval design is scarcely appreciated by soldiers; but the naval designer for the first time tackles his problem under restrictions as to dimensions analogous to those on land. One notes the tendency to "cuts." Compare *Lord Nelson* with *Hood*, approximately the same size, for "standard" tonnage and "full load" tonnage are very different things. To get the enormous thickness of armour needed has meant cutting down speed from exceeding 30 knots to 23, the concentration of armament in three 3-gun turrets forward is a very artificial and debatable feature, forced upon the designer by the vital necessity of economizing weight. If we turn to the post-Washington cruiser, we observe the other side of the medal; the "cut" made is in armour. *London* carries relatively much less armour than *Warrior*, designed 70 years earlier; her weights for armament are also slightly less; the gain, measured comparatively, is almost entirely in speed, 32 knots against 14·8. To get this has required an increase in dimensions from 9,210 tons to 14,000 deep load; in horse-power from 5,267 to 90,000; in cost from about £600,000 to about £2,000,000. Her 3-in. armoured ammunition hoists can be pierced at 3,000 yards by a 5-in. gun, equivalent in weight to the old 68-pdr., she has *no* side-armour, and her armour-deck would be useless against the 8-in. guns of contemporary foreign cruisers. One gets the impression that such armour as the ship possesses is more a "survival" than the result of a reasoned policy.

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The opinion of the balanced critic upon contemporary tank-design will be that the tendency is to attempt too much upon restricted dimensions; designs suffer from the vice of "overcrowding." Brig. Collins in his recent valuable and instructive article has admitted the unsuitability of the present type of medium tank, and that experiment is still necessary to get a really good armoured car. The fault lies less, I am afraid, with our tank designers, who are an extraordinarily able body of men, than with staff officers, who do not always possess a really adequate grasp of the mechanics of this problem, and who perpetually urge the tank-designer to work to "ideal" standards and to produce something to gratify *doctrinaire* theories. "Overcrowding" is familiar to all students of naval design, and it took the naval officer generations to grasp the need for "elbow-room." The U.S.S. *Indiana*, *Oregon* and *Massachusets* are classic instances of "overcrowding" at sea. Designed in 1889, they carried an armament weight exceeding that of *Royal Sovereigns* and *Majestics*—about a third larger; they had 16-in. belts as compared with 9-in. belts in *Majestics*. Their only apparent inferiority was in speed, 16 knots as compared with 18 knots. A popular civilian naval critic made very disparaging comparisons between these and the British ships. But the belts of the *Indianas* were so narrow that when fully loaded they were nearly awash; stops had to be put to save the blast from the 8-in. guns from rendering unworkable the 13·5's; the ports for these were so large and vulnerable that their officers covered them up with painted canvas screens when visiting foreign waters; well-informed American critics admitted that to render these ships efficient would have needed an increase in dimensions by 2,000 tons, and they would even then have been inferior to *Majestics* in speed, endurance, and capacity to fight their guns in a sea-way. Instances of "overcrowding" almost as bad can be quoted from early British battleship designs. And whether it is tanks or ships, the test of a design is not what it looks like on paper, but how it works in practice. Tanks are not likely to meet the enemy with engines freshly "tuned up," men in the pink of condition; they are much more likely to meet the enemy with tracks bespattered with mud and dirt; men weary from the strain of long marching, engines developing "moods." Capacity to stand the rough and tumble of service conditions; a clear field of fire for her guns, absence of interference of gun with gun, are the qualities most urgently needed. Armour looms largely in popular writings anent "mechanization," mainly because their authors are obsessed with the vision of tanks fighting *infantry*; but the tankman's real enemy, in a European war, is much more likely to be another tank, and unless he can settle this, his chances of fighting foreign infantry will be remote, for either his soul will be in Kingdom Come or his body in the hands of the enemy. In the combat of tank *v.* tank, quickness "on the draw" will assume a role far transcending the importance of

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armour. First, *whatever* armour is carried won't really matter a tinker's curse; it will still be vulnerable to a gun-armed enemy; second, the conditions of a duel, tank *v.* tank, recall those of a cowboy fight in a Wild West novel. Given accuracy of fire, a gun heavy enough to do the job, and the man who gets in the first hit—wins. If we are to produce a really efficient tank, we must make more drastic "cuts" in designs; a more generous use of the principle of differentiation—and take a firmer hold on fundamental principles. We cannot afford to approach a practical problem from a standpoint of "philosophic doubt." If, for instance, the tank—and this is admitted—cannot attack infantry armed with anti-tank guns unless covered (*a*) by smoke-clouds, (*b*) by overwhelming artillery fire, isn't her armour after all somewhat superfluous? If she *has* cover by smoke-clouds or artillery, she does not *need* armour; if she *hasn't*, any armour which is a practicable proposition will be riddled anyhow. Why not an *unarmoured* tank? A foreign conscript army, faced with the menace of British tanks, is not likely to build tanks to deal with British *infantry;* it will build tanks to run down and destroy British *tanks*. For such *tank-destroyers*, however, the essential qualities are superior speed and endurance, heavier guns; given equality in dimensions and efficiency of design, the Continental designer can *only* produce such a destroyer by sacrificing armour. But for wire-cutting, moral effect, and surprise attacks, such unarmoured *destroyers* would be just as valuable as armoured tanks.

It seems to me that we must distinguish between tanks needed for colonial wars against rifle-armed tribesmen and the types most suitable for European warfare; a really efficient light or medium tank can only be produced by scrapping armour; the *armoured* tank must be a form of land-monitor, sacrificing speed and cruising qualities to the sheer element of weight and power. The value of such a land-monitor will be as limited as that of the monitor at sea.

Finally, we must not make a fetish of "mobility." It's no use catching one's enemy if he turns out to be a Tartar when caught. There is no great difficulty in producing an anti-tank gun capable of being handled by two men in the fashion of a Lewis gun and of piercing tank-armour up to 300–400 yds. Unless powerfully supported by artillery, tanks are likely to find an attack, even upon an infantry column in movement, no easy business. The tendency is too much to look to *Get-Rich-Quick-Wallingford* theories of winning wars, and to forget that a Continental Army is likely to be handled by men who know their job and who will match "Science" against "Science." In this case, however, superiority can be attained by no means other than superiority of *effort* applied to superiority of *resources*. There are no means actually available or likely to be produced to enable a British Army 60,000 strong to stand up to a Continental Army ten times its own size.

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TABLE OF PENETRATION OF STEEL FOR ANTI-TANK GUNS.

Taken from *Militär-Wochenblatt*, Sept. 25th, 1928.

Calibre.		20 *mm.*			37 *mm.*				77 *mm.*	
Range in metres.	Weight of projectile. M.V. m.s. Depth of penetration in millimetres.	0·14 kg. (·32 lb.)			0·6 kg. (1·35 lb.), 0·8 kg. (1·8 lb.)				6·3 kg. (14·4.lb.)	
		1000	800	600	800	600	800	600	600	400
100		47	35	22	51	33	63	42	87	49
500		35	25	16	39	25	51	35	77	44
1000		24	16	11	27	18	40	28	67	40
1500		16	11	9	20	15	30	22	60	35
2000		11	9	7	16	12	25	18	53	33

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SHISHI BRIDGE, CHITRAL.

Constructed by the Chitral Section, K.G.O. Bengal Sappers & Miners, under LIEUT. A. H. G. NAPIER, R.E.

THERE are two pack transport roads between Drosh and Chitral, one on each bank of the main river. Shishi *nala* joins the main river on its left or east bank about 2½ miles north of Drosh, and therefore must be crossed by the east bank road.

The Shishi stream is easily fordable during the winter months, but during the summer, when the snow is melting, is impassable, and it is also liable to sudden floods.

A field type of suspension bridge, span 301 feet, had been in existence for a number of years, but was accidentally destroyed by fire in 1926. As a result of the destruction of this bridge, the east bank road was closed for military traffic during the summer months.

It was decided to build a new bridge to take pack transport. The present policy is to maintain the east bank road for military purposes up to the standard of a good pack transport road, while the west bank road may be improved for motor traffic. Bridges on the east bank road are not, therefore, required to take loads heavier than pack transport.

Shishi *nala* is a stony river-bed, through which runs a stream 50 or 60 feet wide in winter, and variable in summer up to the whole width of the bed in a flood.

The first proposal was for a timber pile bridge at the site of the old bridge, span 301 feet, 9" x 9" deodar piles at bay interval of 10'. It was, however, doubtful whether the piles could be driven to a safe depth, and experimental pile driving was therefore carried out by this unit in April, 1927. The maximum penetration obtained was 7' in a place where 16' was required for safety; in consequence of this, and of the fact that Shishi stream, when in flood, brings down with considerable force boulders and quantities of logs from avalanches near its source, it was decided to abandon the pile bridge scheme, and to build a suspension bridge.

Accordingly a design was prepared for a suspension bridge, at a new site about 300 yards upstream, where the gorge narrowed to a gap of only 168 feet. This design was approved by the C.R.E., and the bridge was built by the Chitral Section, K.G.O. Bengal Sappers and Miners.

The span was 168 feet clear with high rock cliffs on each bank. New approach roads were required on each bank leading to the new

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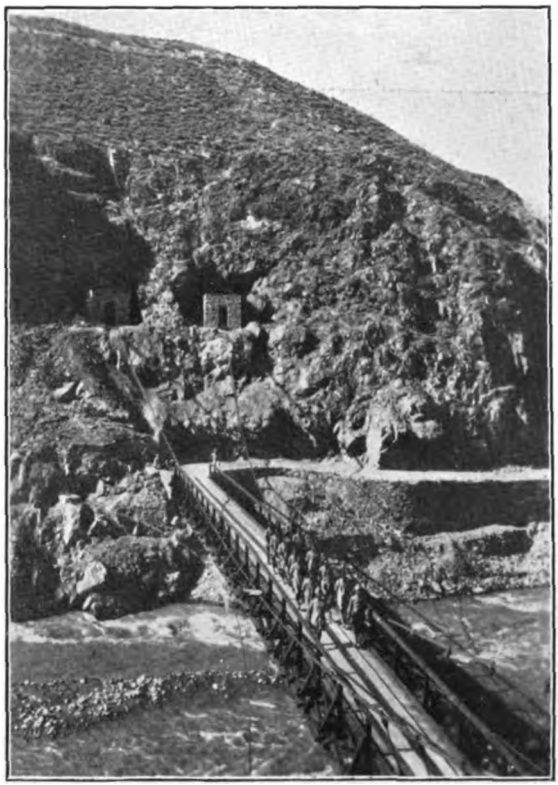
SHISHI BRIDGE, CHITRAL.



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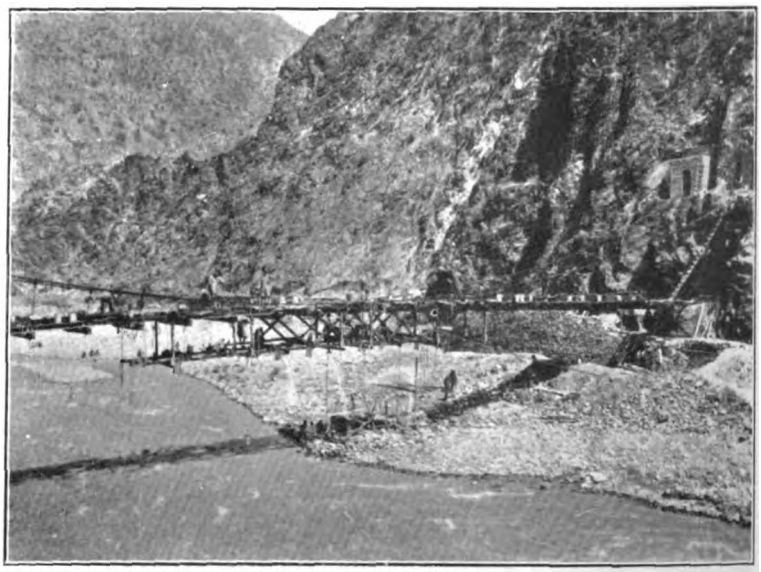

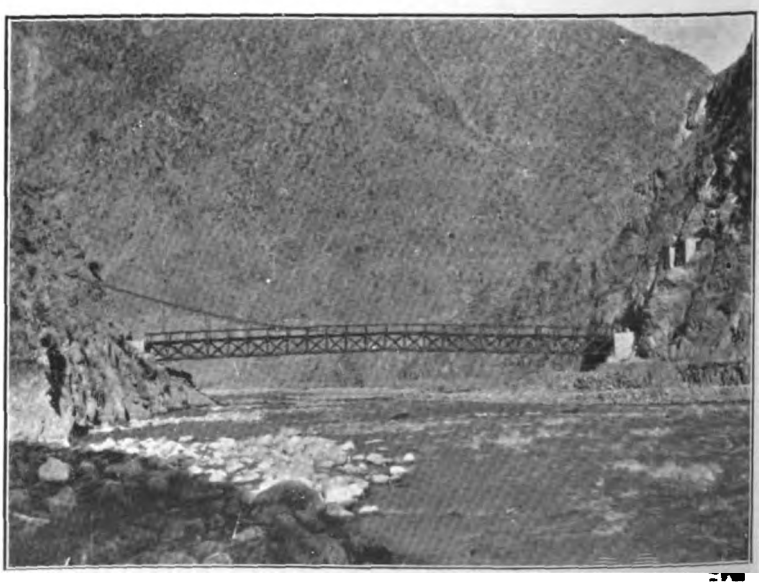

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site from the old site. The construction of the approach roads, over very difficult ground, largely offset the saving on the bridge itself due to the decreased span. Work on approach roads and bridge site was carried out during the winter, 1927–28, by coolie labour by the M.E.S.

It was decided to use a stiffened splayed cable suspension bridge for pack transport.

Clear span, 168 feet.
Width of roadway, 7 feet between handrails.
Dip of main cables, $\frac{1}{12}$ loaded span = 13 feet.
Horizontal splay = $\frac{1}{3}$ vertical dip = 4·33 feet.
Calculated load = 300 lb. foot run equivalent dead load.
Weight of bridge = 280 lb. per foot run.
Wind pressure allowed for = 40 lb. per sq. ft. over exposed area of bridge.

The cables were slung direct from anchorage to anchorage, there being no pier. This was made possible by the height of the cliffs on each bank. The main anchorages were situated on platforms blasted in the face of the cliff. They consisted of reinforced concrete anchor bars, joined to the rock by steel bars in jumper holes, with masonry buttresses in front of the anchor bars, and a weight of masonry on the top. The whole calculated to be of sufficient weight not to slide horizontally on the bottom joint of masonry, assuming a coefficient of friction of ·7, and the dimension of the structure such that the resultant thrust came within the middle third of the base. The anchorages were thus designed to be stable structures, ignoring the fact that they were fastened to the rock by jumper bars.

Each of the main cables consisted of seven steel wire ropes, five of which were $\frac{7}{8}$" diam. steel cable from the Khyber ropeway, and two were $3\frac{1}{2}$" circumference G.I. cable from the dismantled Ghairat Bridge.

A timber girder was used below the roadway, ensuring adequate cross bracing. Effective depth 6 ft.

A new departure was the provision of horizontal bracing for the roadway, by laying the decking diagonally at 45° and spiking it to the booms of the girder. This made the bridge very stiff, and was a great improvement on the Ghairat Bridge, which sways laterally under load.

The wind bracing consisted of $\frac{7}{8}$" diam. steel wire ropes, stretched in a horizontal parabola, one on each side of the bridge, with wind slings to each transom, made of G.I. wire and fitted with adjustable union screws. These wind braces were anchored by R.C. blocks fastened to the rock by steel bars in jumper holes.

The site was very carefully marked out in order to place the anchorages accurately in their pre-determined positions. The

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length of the main cables was calculated and also the position of the slings. Each steel wire rope was carefully stretched over pegs on shore and marked.

Stretching was done by means of a capstan, which enabled approximately the same strain to be put on each rope before marking. The seven ropes forming each cable were placed separately across the gap, each being fastened at the marked points to the anchorages, and passed through its assigned position in templates to enable the whole cable to be bound up over the gap.

The cables were joined up when in position over the gap by putting on the main cable clips and slings at the marked points, movable templates holding each rope in its correct relative position during the process.

The stiffening girder was built on shore, parts were numbered, and it was then dismantled preparatory to re-erection over the gap.

The erection of the stiffening girder over the gap was carried out without difficulty as follows: Transoms and temporary roadway were laid in the ordinary way. The roadway was loaded for the adjustment of cables to correct dip and equal strain. The girder was then built below the temporary roadway, working outwards from the centre of the bridge. This was done by suspending from the roadway movable frames in which the bottom booms and a platform could be rested. Bags of earth were used to load that portion of the roadway, where construction was not in progress. This was to keep the cables in their correct parabolic shape, and to enable the girder to be joined up straight.

By this method of erection it was found that the correct dip of the cables was arrived at without any guesswork or "trial and error" methods.

Wind cables were made up complete with wind slings on shore and were fastened to their anchorages at calculated marks. Very little subsequent adjustment was necessary.

The total time taken to build the bridge was 131 working days. The work included building a hut camp for the unit, and a large dry-stone retaining wall at one of the approaches; dressed stone, sawn timber and all materials had been collected previously.

Working strength :— 1 Indian officer.
1 British N.C.O.
50 Indian O.R.s.
20 experienced local coolies.

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AFGHAN WARS.

By COLONEL F. C. MOLESWORTH.

DURING the last ninety years we have three times been engaged in war with Afghanistan. The first war, from 1839 to 1842, is memorable chiefly for the disastrous retreat from Kabul. In the second war, 1878 to 1881, occurred the massacre of the Minister and his guard, and Roberts' march from Kabul to Kandahar. The third war, 1919, was little more than the repulse of an Afghan attempt to invade India—the first time in history that such an invasion has been foiled. In the third war more men were engaged on our side than in any other war in our history, the Great War and the South African War only excepted.

THE COUNTRY (*Map I*).

Afghanistan, as a reference to the maps will show, is a country shaped like a parallelogram, 900 miles from N.E. to S.W. and 500 from N.W. to S.E. Its extreme north-east angle abuts on the Pamirs—the Roof of the World—whence a number of broken mountain ranges spread fan-wise in a south-west direction, gradually lessening in height until along the Baluch and Persian borders they have sunk almost into the plain. Of its rivers, some, of which the most important is the Kabul, make their way into the Indus, and none, except those which are tributaries of the Indus, reach the sea. The Helmand discharges into the Hamun, a swamp in Seistan, largely in Persian territory, while the Oxus and Hari Rud, which drain the northern provinces, lose themselves in the sand in Soviet territory. These rivers are rapid and unfit for navigation. In many parts water is scarce and often brackish. Cultivation is confined to a few fertile valleys; otherwise the country is sterile. There is little timber except in the higher ranges.

The people call themselves Afghans or Pathans; there are, however, Persians in the west, a Mongol remnant called Hazaras in the centre, Usbegs and Tajiks in the north. All, almost without exception, are Musalmans. Hazaras are of the Shia branch of that religion, and so are disliked by their neighbours, who are Sunnis. The language is Pushtu, but Persian is used in the west and is also the court and official language.

The climate is one of extremes. The winter in the mountainous districts is intensely cold, while the summer is intensely hot in the low-lying parts and warm elsewhere.

The boundaries were ill-defined during the First Afghan War, and to a slightly smaller extent until after the Second War.

The neighbours of Afghanistan are British India on the east and

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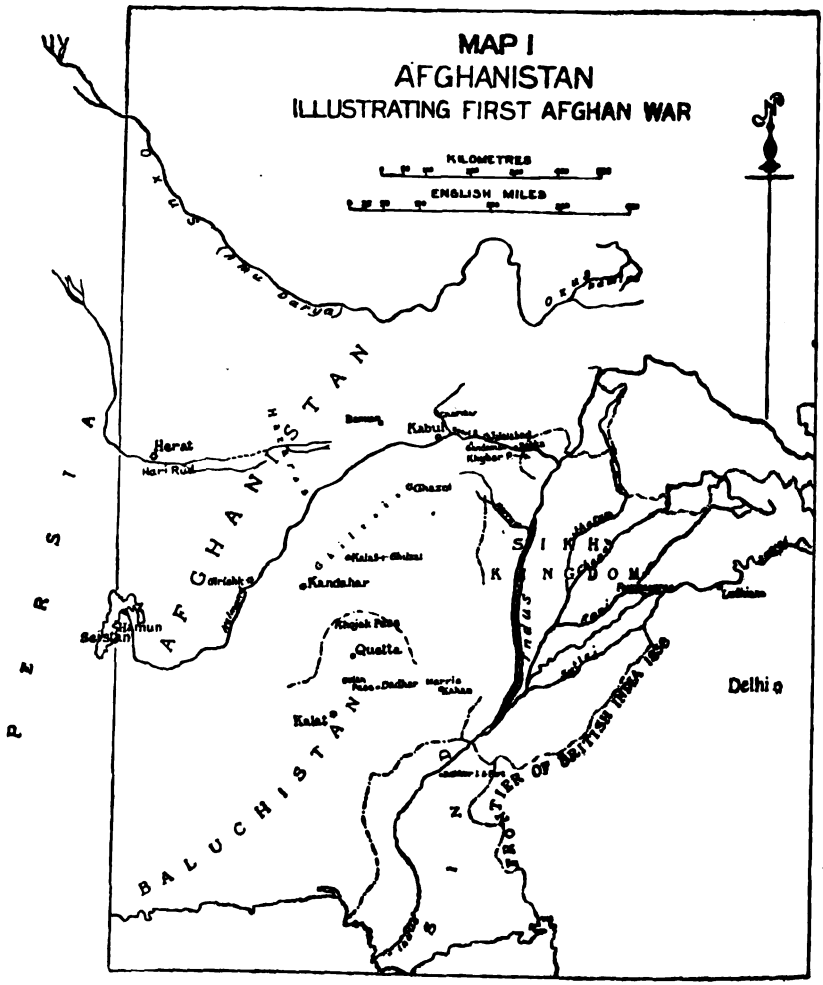
south, Persia on the west, and the U.S.S.R. on the north. It is noteworthy that in the latest Soviet maps the southern boundaries of Turkmanistan, Tajikistan and Usbekistan, recently formed Soviet republics, are unmarked, but the boundaries shown between these states penetrate far into Afghanistan and Persia. Chinese territory marches for a few miles with Afghanistan in the Pamirs.



EVENTS LEADING UP TO THE FIRST WAR.

In the middle of the eighteenth century, Nadir Shah of Persia, the last of the great Asiatic conquerors, overran the whole of the territory now known as Afghanistan, and even sacked Delhi. On his death, one of his generals, Ahmad by name, carved out for himself a kingdom with its capital at Kabul. His dynasty remained on the throne until 1929. Whenever the reigning monarch has

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been strong enough, the kingdom has been fairly united, but as often as not the control of outlying provinces has been of the weakest, and not infrequently there have been internecine wars between rival claimants to the throne, and many tribes in Afghan territory have given the Afghan government almost as much trouble as those on our Indian North-West Frontier have to us.

In 1837, the Persians, with Russian help, besieged Herat; the city would almost certainly have fallen but for the fortuitous presence of Eldred Pottinger, a subaltern of Bombay artillery, who infused such life into the defence that, after a siege of eleven months, the enemy retreated.

The Indian Government, under Lord Auckland as Viceroy, was naturally alarmed at this attack, and although the British frontier at the time was the Sutlej, between which river and Herat lay the independent kingdom of the Sikhs and the greater part of Afghanistan, it was decided to prevent future menaces by placing a friendly king on the throne of Kabul. An unfortunate choice was made in Shah Shuja, who had been driven out some thirty years before and was living in Ludhiana. He was permitted to raise an army of Indians with British officers, which, in conjunction with a British force, was to invade Afghanistan and set him on the throne.

The British force was composed of two divisions from the Bengal army with cavalry and guns, under Sir W. Cotton (12,000 men and 48,000 followers), and a Bombay contingent of a brigade, under Major-General Willshire. The whole was to be under the command of Sir John Keane. Shah Shuja's force consisted of about 6,000 men. The command of this force was under the Political officers who accompanied it—an arrangement which was to produce friction, defeat, and disaster.

The Persians abandoned the siege of Herat in September, 1838, and the Indian Government might thereupon have, with good face, abandoned the whole enterprise. The Governor-General, however, decided to carry it through. On December 2nd, Shah Shuja's force started from Ferozepore and the British force followed it eight days later. The direction of the march was south-west down the Sutlej, in order to effect a junction with the Bombay force, which had to travel by sea and land in Sind—then foreign territory. By this route also Sikh territory was avoided, as it was in the highest degree desirable to avoid a collision with that power.

First Afghan War.

First Phase.

The Army of the Indus, as the Bengal Force was named, began its march on December 10th, following Shah Shuja's army. Troubles arose almost as soon as the force was in motion. The provision of depots of supplies along the route had been entrusted to Political

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officers, who, in many cases, failed to collect enough, and the consequence was that the troops were speedily reduced to half rations. Camels were over-worked and not allowed sufficient time for grazing. Their drivers deserted in large numbers, taking their animals with them. Thus the efficiency of the force was diminished long before the enemy was encountered.

On January 24th, 1839, the army reached Bukkur, the selected crossing-place of the Indus, and here came the first great engineering feat of the campaign. To bridge the river, here about 1,000 yards wide, there were available only the local large, unwieldy boats. The sappers had to cut planks, make anchors and even manufacture ropes. Difficulties were, however, successfully surmounted, and the force proceeded on its way, heading in a north-west direction for the Bolan Pass.

Now came a stretch of desert, where water was scarce and often brackish, and supplies almost wanting. The army had perforce to cross this waste in detachments; the natives of those parts were enterprising and proceeded to kill stragglers and drive off baggage animals, and the Politicals with the force were averse from reprisals. The result was that the Baluch raiders became bolder, and military difficulties increased. The desert was, however, surmounted, and by March 10th the force was concentrated at Dadhar, at the foot of the Bolan Pass.

The Pass is a narrow defile, running for some 50 miles through a jagged mass of mountains. Such road as existed was little better than the bed of a stream. Through the pass toiled the army, losing every few yards camels and bullocks, whose carcases remained to poison the air and water. Marauders were ever on the look-out for stragglers. Nevertheless, the force got through somehow, and on March 26th Quetta, then a mud village, was reached, and here, on April 6th, Sir J. Keane, who had up till then accompanied the Bombay force, arrived and took over charge.

The situation that faced him was not encouraging. The fighting force was on half rations and the followers were almost starved. Supplies could not be brought up in time and local resources had long since been exhausted. The only course to take was to move on Kandahar, and so, on April 7th, the army resumed its march. The Khojak Pass presented difficulties similar to those in the Bolan, though on a smaller scale; yet the staff had not profited by its experience, and a terrible jam occurred. Most of the transport remained loaded up without food or water, for two days and the intervening night. This was, however, the last serious difficulty, and Kandahar was occupied, fortunately without resistance, on April 26th. The cavalry, owing to bad and insufficient water, little or no grain, and, later, a surfeit of green fodder, had practically ceased to exist.

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We must now revert to the Bombay Force. Sind, it must be remembered, was a foreign, and potentially hostile, country. The first operation of the force was, therefore, the landing on an unknown coast, which was effected between November 27th and December 3rd. Negotiations were made with the Amir of Sind for the safe passage of the force, which, without opposition, marched up the right bank of the Indus and struck out across the desert, where, owing to the advancing season, it suffered considerably from heat, and reached Dadhar on April 5th. From there on it followed in the footsteps of the Bengal force, which it ultimately joined at Kandahar on May 4th.

A halt was now necessary to await supplies, which were ultimately obtained by the harvesting of local crops as well as the arrival of a convoy from India. During this period the only military movement of any importance was the occupation of Girishk on the Helmand. On June 27th the force marched for Kabul, with the Indian troops still on half rations.

The way was barred by the fortress of Ghazni, impregnable in native opinion, where the army arrived on July 21st, with only three days' rations in hand. The siege train, such as it was, had been left behind at Kandahar. The walls of the fortress were sixty feet high and immensely thick, the gates, with one exception, had been walled up, and there was a wet ditch. Sir John Keane decided to blow in the one unguarded gate, as the alternative to starvation. By astonishing good luck, as well as by audacity, the gate was successfully demolished by the Sappers, one of whom, Lieutenant Durand, lived to become Lieutenant-Governor of the Punjab.

No further resistance was met, and Kabul was occupied on August 7th. Dost Muhammad, the Amir, had fled, and Shah Shuja was placed on the throne.

So ended one of the most astounding marches that the British Army, or for that matter any other army, has ever been called on to make. The distance traversed, 1,500 miles, is greater than that between Moscow and the French frontier. Great though the military blunders of the campaign had been, the commander and army certainly deserved credit for the successful accomplishment of their stupendous task.

By this time a line of communication had been opened through Sikh territory and the Khyber Pass. In the latter, however, the tribesmen were invariably hostile, and gave a great deal of trouble to successive convoys.

Second Phase.

With Shah Shuja on the throne, and the country fairly peaceful, it was now possible to evacuate a proportion of the British and Indian troops. The Bombay force was the first to go. On its

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way it was employed to take Kalat, whose *khan* had given a good deal of trouble both during and after the passage of the army through his territories. The place, a walled city garrisoned by 2,000 Baluchis, was taken by assault by Major-General Willshire, with 1,000 troops and a few light guns, in the space of two hours.

Keane followed, taking with him all of the Bengal force, except such as were left to garrison the country. He handed over command to Sir W. Cotton.

The force remaining in Afghanistan now consisted, in addition to Shah Shuja's army, of eight battalions, two of which were British, two Indian cavalry regiments, and some artillery. The places garrisoned were Kabul, with an outpost at Bamian, Jallalabad and Dakka on the northern line; Kandahar and Quetta on the southern line, with Ghazni as a connecting post. Shah Shuja's force was entirely, and the British force to a certain extent, under the Resident, Sir W. Macnaghten. This dual control was considerably to blame for the subsequent disasters. The force was often frittered away in useless expeditions, in the initiation of which the military commanders had no say at all.

Troubles meanwhile had arisen on the lines of communication. The country south of the Bolan Pass is one of the hottest on earth. During the summer of 1839, many officers commanding posts marched their men up to Quetta and other cooler places without troubling to ask for leave—such was the state of discipline at the time. Cholera appeared among the rest, and the surrounding tribes were not slow to take advantage of the disorganization.

Kalat was captured by the insurgents and had to be recovered. On the other side of the lines of communication a small post at Kahun, originally placed to keep the Marris in awe, was forced to surrender after two unsuccessful attempts at relief. Quetta and Dadhar were attacked and only relieved when large reinforcements arrived from India. The Politicals endeavoured to reduce these incidents by wholesale payments to certain tribes, a policy which seldom produces the result desired.

So passed 1840. By the beginning of 1841 everyone concerned, from the Government of India downwards, with the possible exception of some Political officers with the force, was heartily sick of the enterprise, and wished for nothing more than the immediate evacuation of Afghanistan. This, however, would have ensured the massacre of Shah Shuja as well as of any friends the British had in the country. A new Commander-in-Chief arrived in June, 1841—Major-General Elphinstone, who, invalid as he was, was not able to stand up against "the gentleman employed to command the army," as the great Duke of Wellington referred to Sir W. Macnaghten. A brigade from India, consisting of the 44th (now the 1st Battalion,

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Essex Regiment) and some Indian battalions, arrived about the same time, after having successfully acted as escort to Shah Shuja's harem, consisting of 600 women, which was now brought up from India. The brigade relieved the 13th L.I. and an equal number of Indian troops, which were now ordered to move to Gandamak, *en route* to India, under Colonel Sale of the 13th.

Sale started on October 20th and reached Gandamak, not without some fighting; for the Ghilzais, one of the most powerful of the Afghan tribes, were up in arms against us. On this march, we hear for the first time of the practice of "piqueting the heights," which has since become a routine precaution of frontier expeditions. In spite of this, there were two occasions when British and Indian troops had to retire before Afghan tribesmen.

At Gandamak, owing to events presently to be related, Sale received orders recalling him to Kabul. He professed himself unable to comply, alleging deficiency of transport and that he was encumbered with wounded. These were probably sufficient excuses, but he had none for what he actually did. He moved his force to Jallalabad, 30 miles nearer India, and by the same distance further from Kabul.

Scarcely had Sale left Kabul when the storm burst. Practically the whole country rose in arms; the small force at Charikar was overwhelmed, and some of the Shah's force murdered their British officers and joined the insurgents. Burnes, one of the Political officers, was murdered in Kabul city, almost within sight of the British force, and nothing was done to avenge his death.

The force, numbering about 4,500 combatants and three or four times that number of followers, had constructed, and was occupying, fortified cantonments north of the city. With incredible stupidity, the treasury had been placed in a house in the city, and almost the entire store of rations for the force was in a fort some 300 yards outside the cantonment ramparts. The treasury was speedily overrun, and the commissariat fort soon shared its fate, and only half-hearted attempts, all of which failed, were made to recapture it. Thereafter the army subsisted on what it could obtain by raids on neighbouring forts, or purchase at exorbitant rates from friendly Afghans.

Cantonments were never seriously attacked; yet constant operations took place, mostly to recover forts and other points of vantage whence the enemy annoyed our troops. These affrays were generally mismanaged, and as a result the force lost its morale, and a dismal spirit of croaking set in. The truth was that General Elphinstone was too much of an invalid to command the army Winter was coming on and all began to talk of a retreat.

Sale was summoned from Gandamak, with what result we have seen. Nott, whose force had kept its tail up, was directed to send

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a brigade, which however found its way blocked by snow and had to return to Kandahar.

At last Macnaghten opened negotiations for a retreat, the terms of which were that the British should evacuate Afghanistan with transport and supplies provided by the Afghans, and that Dost Muhammad, who had, in a fit of depression, surrendered himself, should be restored to the throne. Unfortunately for himself, Macnaghten listened to a proposal by Akbar Khan, son of Dost Muhammad, went to meet him with only a few companions outside, but within sight of, cantonments, and was speedily murdered. The army made no attempt to avenge his death.

A comparison has already been made between this expedition and that of Napoleon to Moscow in 1812. The events which follow provide an even more exact one. On January 6th, 1842, the British force evacuated Kabul, and, ill-fed and ill-clad, began its march towards India. Snow covered the ground, and even at mid-day the temperature was below freezing point. Fruitless negotiations were opened every day with the Afghan chiefs, and many officers, including General Elphinstone, were removed as hostages.

For six days they struggled towards India, losing many men from Afghan bullets, but more from cold and hunger, until one wounded man, Dr. Brydon, the sole survivor of 16,000, rode into Jallalabad.

The hero of the march was Brigadier Shelton, of the 44th. Twenty-nine years before he had stood unmoved before his tent in front of San Sebastian, while the surgeons removed from its socket his right arm. During the retreat he was the life and soul of the army, hurrying from point to point, rallying fugitives, never sparing himself, until, on the fourth day of the retreat, he was hurried into captivity along with his general. The 44th covered themselves with glory, and "44th Hill," near Gandamak, is the name given to the place where the last survivors gave a terrible account of themselves.

The task before the Afghans was now to drive the remaining British out of the country before reinforcements could arrive. In this they were singularly unsuccessful. It is true that the garrison of Ghazni was overwhelmed, but Kalat-i-Ghilzai put up a very strong defence, and the Third Regiment of Infantry of Shah Shuja's force, which took part in it, was taken on the strength of the Indian Army, and is now known as the 2nd Battalion (Kalat-i-Ghilzai) of the 2nd Bombay Pioneers. The garrison was eventually relieved by Nott, in spite of the fact that he had his own troubles to contend with.

The chief interest centred round Jallalabad, where Sale arrived on November 12th, and was attacked on November 13th. The attacks were never pressed hard, for at all times he seems to have been free to retire to India. Once an earthquake laid low his

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defences, but the energy of his Engineer officer, Broadfoot, restored them before the enemy tried to take advantage of his misfortune.

Reinforcements for Sale were on their way, but the first attempts to force the Khyber were unsuccessful, largely because the sepoys were disheartened, and a Sikh contingent, sent to help, was actually mutinous. It was not till Major-General Pollock,* of the Bengal Artillery, arrived with an additional brigade that discipline was restored. The combined force then marched through the Khyber with little loss, and relieved Sale. By this time, Government had decided to recover the prisoners and then to evacuate Afghanistan as soon as possible. Pollock, therefore, advanced to Kabul and burned the great bazar. Nott had meanwhile brought the greater part of his force from Kandahar, and the two divisions evacuated the country *via* the Khyber, where the Khyberris, up to the last, molested the retiring troops. Dost Muhammad was restored to the throne in place of Shah Shuja, who had elected to stay in Kabul, where he met his death.

The results of the War were deplorable. Everything we had fought for had been given up, and a lasting legacy of Afghan distrust of the British bequeathed. Yet the difficulties of a campaign in an inhospitable country, 1,000 miles from British territory, were enormous. It is true that there was one appalling disaster, but even this might have been prevented had a general of the calibre of Nott been in command at Kabul.

The Sappers came well out of the campaign. Mention has been made of Durand. Broadfoot, at Jallalabad, single-handed stood out against retreat to India, when that course was proposed in a council of war, and by sheer force of will converted Sale and the rest to his way of thinking. Lieut. Sturt, although suffering from a knife wound which prevented him from dressing, staggered to his feet to direct the operation of demolishing a small fort outside the Kabul entrenchment; he was the only Sapper officer to perish in the retreat. Fortescue records some other instances where commanders consulted, and took the advice of, their engineer officers, on matters quite outside their normal duties, preferring their advice apparently to that of their staff.

Events Between the First and Second Afghan Wars. (*Map II.*)

It was not long before British India and Afghanistan became actual neighbours. Sind was annexed by the British in 1843, some of Nott's battalions, on their return to India, taking part in its subjugation. Then the Sikhs were conquered, and the Punjab annexed, after two hard-fought campaigns (1845–9). The old Sikh border then became our border, though between this line and the country subject to the Amir lay a belt of independent tribes. To

* See note on page 614.

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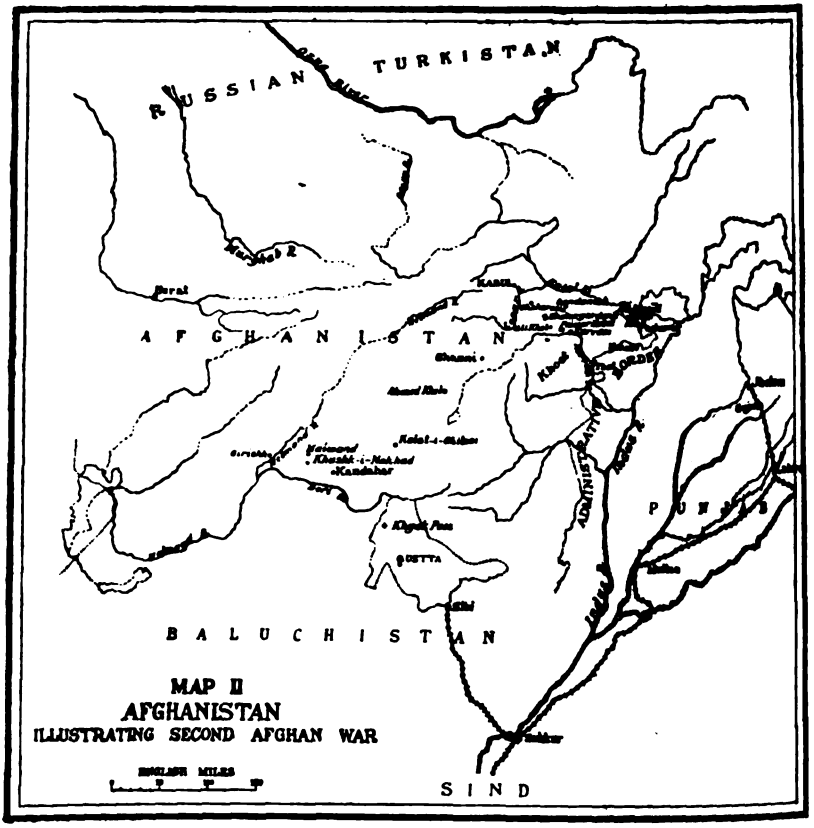
this day, this old border line forms, generally speaking, the administrative boundary of British India. Dost Muhammad sent a force to help the Sikhs, which took part in their final defeat at Gujrat, and was pursued in ignominious rout through the Khyber.

Then, in 1857, came the Mutiny, in the suppression of which the newly-conquered Sikhs gave us invaluable assistance. It was long doubtful what attitude Dost Muhammad would adopt, but the attitude of the Sikhs, as well as his recent experiences in the Sikh War, led him to a policy of non-intervention.



On the south border we had, more or less peacefully, extended our control over Baluchistan, and in 1876 Quetta was annexed to India and a garrison established there.

Dost Muhammad died in 1863, and was succeeded by his son Sher Ali.

All this time, the Russian dominions were spreading steadily southwards. Events in Turkey, where war between ourselves and Russia at one time seemed probable, led to a growing distrust of Russia's aims. In 1878, Sher Ali received a Russian mission and

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immediately afterwards refused admission to one of ours. It was therefore decided to send a mission backed by force, and an ultimatum was accordingly sent.

Our railways at this time ran as far as Jhelum, 180 miles from the frontier, and Sukkur, which were connected by a line running through Lahore. During this period we had been in a state of almost continuous warfare, now with one and now with another of the trans-frontier tribes, whose attitude in the event of another Afghan war was always problematical. One or two minor campaigns actually did take place while the Second Afghan War was in progress.

In the thirty-six years that had elapsed since the First Afghan War, the Amirs had raised an army, estimated in a police report—there was no Intelligence Department in India at that time—as 62 infantry battalions, 16 regiments cavalry, 49 batteries of elephant, horse, mule, and bullock guns, in all about 52,000 men. The value of most of this force was problematical, but we could be sure, in the event of our invading Afghanistan, of strenuous resistance from local tribesmen, now very much better armed than when we had previously entered the country.

Second Afghan War.

First Phase.

It was decided to invade Afghanistan by three routes; with two of these, the Khyber and Quetta-Kandahar routes, we are already familiar. The third, known as the Kurram line, led *via* Kohat up the Kurram valley and then over two passes, the Paiwar Kotal and the Shuturgardan (or camel's neck) to Kabul.

The forces detailed to operate on these lines were the Peshawar Valley field force, under Sir Sam Browne, consisting of one cavalry and four infantry brigades (with one of each in reserve); the Kurram Valley column, under Major-General Roberts (subsequently Earl Roberts), of six battalions infantry with cavalry and guns; and the Kandahar column, under Lieut.-General Stewart, of two divisions; while several brigades were organized in India to act as reserves.

War was declared on November 20th, 1878, and on the same day Sir Sam Browne entered the Khyber. The Afghans here had taken up an extremely strong position across the pass, centring on the fort of Ali Masjid. A frontal attack proved fruitless, but the Afghan retreat was threatened by a wide turning movement through the mountains to the north, whereupon the position was evacuated during the night. Twenty-four guns were captured.

The Peshawar Valley field force then advanced slowly as far as

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Gandamak. Little further resistance was made by the Afghan regulars, but the local tribesmen gave us considerable trouble.

Sher Ali died soon after the invasion of his country, and was succeeded by his son, Yakub Khan, who speedily came to terms, and on May 26th, 1879, signed the treaty of Gandamak, by which he agreed to receive a British Minister at Kabul and to cede the Khyber, Kurram and Chaman. The Peshawar Valley field force then withdrew to the Khyber.

The Kurram Valley force began its march from Thal on the same day as the Peshawar force At first its advance was unopposed, for the inhabitants of the Kurram Valley were well disposed, but the Afghans had prepared a position on the Paiwar Kotal, which was naturally very strong. The difficulties of the attacking force were great, as it was impossible to reconnoitre, and the summits of the hills were thickly wooded. A night march was, however, made, and after some sharp fighting the Afghans retreated, losing 17 guns.

Difficulties of supply and transport prevented a further advance, and consequently the force contented themselves with occupying Ali Khel, on the west side of the Paiwar Kotal. Troops were retained in the above positions during the summer.

Further south, the Kandahar field force advanced almost unopposed to Kandahar, and occupied Girishk and Kalat-i-Ghilzai. The Khojak Pass, as in the First War, proved a difficulty. The 5th and 9th Companies of the Bombay S. & M., aided by Pioneers, constructed a ramp for guns, which, for the first 450 feet of its length, sloped at 30°, and thereafter at a slighter gradient for 400 yards.

The force had the usual trouble with tribesmen. Mention should be made of a certain Lieut. Wells, R.E., who, in command of 36 men of two Indian cavalry regiments, scattered a band of marauders, killing the leader, his two sons and his nephew.

The force remained in occupation of South Afghanistan all the summer, as it was unwise to risk marches during the heat. The evacuation of Kandahar was begun on September 1st, but was stopped on September 3rd, owing to events now to be related.

Second Phase.

On the 24th of July, Sir Louis Cavagnari, the British envoy, arrived at Kabul with an escort of 75 of the Q.O. Corps of Guides, under Lieut. Hamilton, V.C., a secretary, and a doctor. They were given quarters in a house within 200 yards of the Amir's palace. On September 3rd they were treacherously attacked by Afghan regulars. For nearly the whole day they kept up an unequal fight. One by one the British officers fell. The sepoys fought on until they were exterminated to a man. In the words of the official commission which investigated the massacre, "The annals of no

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army and no regiment can show a brighter record of devoted bravery than has been achieved by this small band of Guides." The Amir was unable, or unwilling, to put a stop to the carnage.

It was at once decided to occupy Kabul and avenge the outrage. The Kurram force was nearest to the hostile capital, and was obviously the instrument to use. It was, however, short of transport, and could take the field only by using the transport of the Peshawar field force, which was thereby rendered immobile. Even with this assistance, it could only advance half at a time; the leading portion marching while the rest halted until the transport was once more available. The force, now designated the Kabul field force, was placed under Sir F. S. Roberts, and consisted of 1 cavalry and 2 infantry brigades, with two more on L. of C. They advanced slowly but steadily on Kabul, which was occupied on October 9th, after a severe action at Chaharasia, immediately south of the city. The Amir, who had surrendered, was deported to India.

Once in Kabul, the position of the force was somewhat precarious. The Kurram route was soon afterwards closed by snow, while the Peshawar force was unable to advance immediately owing to lack of transport. Moreover, the Afghans were collecting in very large numbers, estimated at 60,000, no doubt expecting a repetition of the events of 1841–42.

The General had, with great foresight, concentrated his force, numbering about 7,000 men, into a fortified enclosure built by the late Amir for his troops, named Sherpur. This was rectangular in shape, about 3,000 yards from E. to W., by 1,000 yards from N. to S. Two of the sides were formed by a wall 16 feet high, with banquette and loopholes, but on one, the eastern side, the wall was unfinished; the fourth, or north, side was unprotected, but a range of hills, known as the Bimaru heights, gave some amount of cover, and attack from this side was unlikely as at a distance of 1½ miles was a marshy lake several miles long. The country round in all directions was flat, but several villages, which it was deemed impolitic to destroy, masked the field of fire. The position was strengthened and supplies collected.

Several attempts were made to disperse the enemy, now rapidly collecting from every side; but their numbers were too great, and Sir F. Roberts decided to retire into Sherpur. Scarcely had he done so when a fierce attack was made on the position. After a few hours' fighting the Afghans retired, losing about 3,000 men, with insignificant losses to our own people. A few days later (December 27th) the force joined hands with the Peshawar column.

On the southern line, the evacuation of the country was summarily stopped on receipt of the news of the massacre at Kabul. Kalat-i-Ghilzai was re-occupied, and transport collected for a march on Kabul. By this time the railway had advanced as far as Sibi.

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At the end of March, a force of 2 brigades, under Lieut.-General Sir D. Stewart, leaving a garrison at Kandahar, began its march to Kabul. One sharp action was fought at Ahmad Khel, about mid-way between Kalat-i-Ghilzai and Ghazni, where a body of Afghan horse, backed by fanatics on foot, supported by about 16,000 of the enemy infantry, suddenly attacked the column on the march. After an action lasting only an hour, the Afghans were utterly defeated. Our force, with a loss of 7 killed and 124 wounded, continued its march, and by the end of April had occupied Ghazni and joined hands with Roberts. Fighting of some severity continued in the neighbourhood of Kabul for many months.

The Political authorities were meanwhile looking for an Amir; a candidate was soon forthcoming in the person of Abdurrahman, a nephew of Dost Muhammad, who had been for many years an exile in Russian Turkestan. He returned to Kabul, and was formally installed as Amir. As soon as this occurred the evacuation of North Afghanistan began, but took an entirely different course from that expected owing to the receipt of news of a disaster to the South Afghanistan field force.

This disaster was the result of an encounter with the forces of Ayub Khan, son of Amir Sher Ali. He had collected a force, estimated at 20,000 men, in Herat, and in June began to march towards Kandahar. The Wali of Kandahar moved out with local troops to meet him, supported by a brigade of British and Indian troops under Brigadier-General Nuttall. When the force arrived at the Helmand, the Wali's troops deserted, and lack of supplies drove Nuttall's force to Khushk-i-Nakhud, about half-way between the Helmand and Kandahar. Ayub followed up, and on July 27th, 1880, was reported at Maiwand, about 12 miles N.E. of Nuttall's force, and so in a position to threaten the British communications. Nuttall moved to attack, carrying with him his whole train and his sick, for he had insufficient men to leave a detachment. Very soon he found himself in the presence of an immensely superior force. The enemy pressed back his line into a horse-shoe, and even his baggage guard was hotly engaged. At length, after standing considerable punishment and losing most of its British and Indian officers, an Indian regiment broke; this was the signal for a general retreat, which speedily became a rout. The broken army covered the 45 miles to Kandahar in 33 hours, losing guns and stragglers.

The 66th (now the R. Berkshire Regiment) covered themselves with glory. Out of the 19 officers and 497 men, 12 officers and nearly 300 men were reported killed or missing. Most of these perished in a last stand in a walled enclosure, where also fell Lieut. Henn, R.E. The enemy suffered severely, and were unable or unwilling to make any effective pursuit.

The troops remaining in Kandahar, with the defeated remnants

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of Nuttall's force, now prepared to stand a siege. Cantonments were evacuated and the troops concentrated in the city, a walled enclosure about 6,000 yards in perimeter, whose inhabitants were cleared out. The place was besieged for about a month by Ayub's army; no serious attack was made, but a sortie, aimed at the clearing of a neighbouring village, resulted in a loss of 14 officers killed and wounded.

Relief came from the direction of Kabul. On receipt of news of Maiwand, Roberts was placed in command of a force, known as the Kabul-Kandahar force, consisting of an infantry division, a cavalry brigade, and three batteries of mountain guns. It left Kabul on August 8th, and from that date until its arrival at Kandahar was absolutely *en l'air*. There was practically no opposition, but in the later stages the force suffered from heat, and the wastage of transport animals was heavy. At Kalat-i-Ghilzai, where a halt of one day was made, the small garrison was picked up and carried along. Kandahar was reached on August 27th. A distance of 280 miles had been traversed in 20 days, or 19 actual marches.

The fact was deservedly commemorated by a special medal. Yet, as we have seen, Sir D. Stewart, with a smaller force, had already traversed the route, and fought a battle to boot.

The task now remaining to Roberts was to defeat Ayub Khan, whose army had retired from before Kandahar and taken up a position in the hills N.W. of it. In this task Roberts was completely successful, dispersing the enemy and capturing all his artillery, including our guns lost at Maiwand.

In the relief of Kandahar Roberts just forestalled a force under Major-General Sir R. Phayre, which advanced from Quetta, and reached Kandahar on September 3rd. This force had immense difficulties to overcome; on the receipt of news of Maiwand, the whole countryside from Sibi to Chaman rose in arms, and the usual difficulties of collecting supplies and transport were increased by scarcity owing to the failure of the rains for the past two years; while intense heat made marching difficult.

For many months the question of the retention of Kandahar was debated, it was thought that its evacuation, before Abdurrahman had consolidated his power, would lead to anarchy. It was eventually decided, however, to evacuate all S. Afghanistan, retaining only Chaman. The return march to India, in April and May, 1881, was uneventful. From that time the only representative of British rule in Afghanistan was an Indian officer as Political Agent at Kabul.

Little mention has been made of the L. of C.; but the difficulties here were even greater than during the First Afghan War, as the inhabitants were much better armed. To take the period immediately before the final evacuation of Kabul, when the force there

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consisted of one infantry division and one cavalry brigade, on the L. of C. from Peshawar to Kabul, both exclusive, were three cavalry regiments and 18 infantry battalions; at Peshawar were a cavalry brigade and a strong infantry brigade. The Kurram force, whose role during the summer of 1880 was to protect an alternative route from India to Kabul and Ghazni, consisted of one cavalry and two infantry brigades. Kandahar and Kalat-i-Ghilzai accounted for one weak cavalry and two weak infantry brigades, while on the L. of C. from Sibi westwards were three cavalry regiments and 14 infantry battalions. The L. of C. troops, in effect, equalled what would now be called the striking force.

Though the Sappers had little work of a spectacular nature, they were busily employed on every line of advance. The defence of Sherpur and Kandahar gave them work of a most congenial kind. Nearly every S. & M. Company formed part of the force at one time or another. Capt. Leach, R.E., attached to the Survey, gained the V.C. for covering the retirement of his party and escort, after some hand-to-hand fighting, during which he received a knife cut on his left arm.

PERIOD BETWEEN THE SECOND AND THIRD AFGHAN WARS. (*Map III.*)

Amir Abdurrahman and his son and successor Habibullah ruled over a country which was probably more united and peaceful than since the days of Nadir Shah. There were, of course, internal troubles, and Russian aggression on the North Frontier, culminating in the Panjdeh incident of 1885, nearly led to war between Great Britain and Russia. But, generally speaking, except among frontier tribes, the authority of the Amir, if not undisputed, was paramount.

The Panjdeh incident led to the exact delimitation of the Russo-Afghan border. The west and south borders were also defined, and an agreement made in 1893 described the spheres of influence of Great Britain and Afghanistan among the frontier tribes. The boundary is known as the Durand line, and between this and the old administrative border lie the Wazirs and Afridis and many other tribes we have had to punish so often in the past for their raids on British territory.

Railway communication in India was improved. The N.W. Railway was carried on as far as Jamrud and Kohat, and from the latter place a narrow gauge line ran to Thal. Further south, the line from Sibi was taken *via* Quetta to Chaman, where material was stored for an extension to Kandahar. Railway bridges crossed the Indus at Attock, Khushhalgarh, Sukkur and Kotri. But there was no railway connection to the west of the Indus, except between Kotri and Sukkur.

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MAP III

AFGHANISTAN

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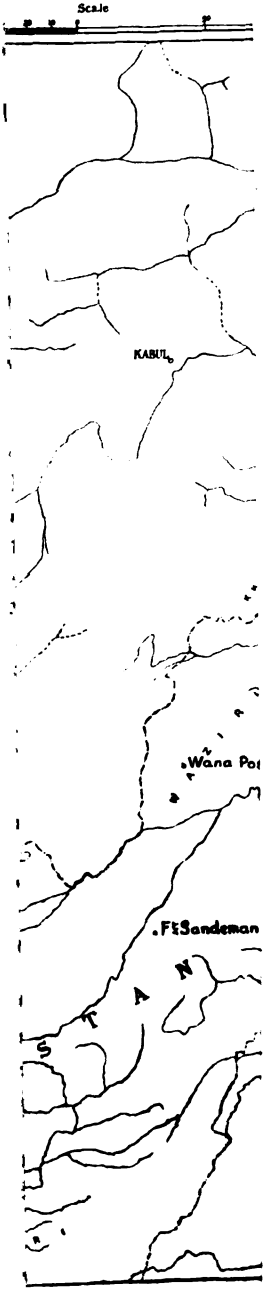

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Road communication was not so far forward. The Grand Trunk Road ran alongside the railway up to and through the Khyber, but Quetta had practically no road communication with India, and the only lateral road was one connecting Peshawar with Kohat, Bannu and Dera Ismail Khan, whence a series of unmetalled tracks joined the Quetta system. Karachi was, and still is, isolated from the rest of India.

The Great War produced a series of minor frontier campaigns from Swat in the north to the Marri country in the south. Afghanistan, though attempts were made by German agents to attach it to the Central Powers, remained neutral.

To prevent the arrival of German agents, we and the Russians stationed small forces along the Perso-Afghan frontier. On the Russian collapse, this force, known as the East Persia Cordon, extended northwards to the N. Persian border. By November, 1918, this force had reached and passed Merv in Trans-Caspia; the line of communications was 1,250 miles long, less than half of which was by rail.

In India itself, in addition to a covering force on the frontier and internal security troops, a force consisting of four divisions was kept in readiness for a limited offensive. The British troops in these divisions were almost all territorials, as all except nine battalions of regular infantry and a few regiments of cavalry and brigades of artillery, had been sent overseas. By this time, of course, the territorials had hardened into first-line soldiers, but by the spring of 1919 were naturally anxious for relief, which could not be effected until new regular battalions were available from home.* The Indian troops were largely recruits, and it was calculated that with each battalion there was an average of 1·7 pre-war British officers only. Severe disturbances, the worst since the Mutiny, took place in April, 1919. India was almost denuded of medical and engineering stores, and the hot season was one of the severest known. The Afghans could not, in fact, have chosen a better moment for the invasion of India.

In Afghanistan things remained quiet until, in February, 1919, the Amir was assassinated, and was succeeded by his young son, Amanullah. The War party immediately took up the reins of power and, at the beginning of May, proclaimed *jehad*.

The Afghan regular army consisted of about 7,000 sabres, 42,000 rifles and 260 guns. A large number of tribesmen, estimated at 120,000, well armed with modern rifles, was available to act in conjunction with the regulars, and there were potential allies in every tribe along our border.

* Demobilization, closed during the disturbances of April, 1919, was opened again on May 5th, but closed the next day on the outbreak of the Afghan War.

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THIRD AFGHAN WAR.

On May 3rd, 1919, Afghan troops occupied certain springs in disputed territory in the Khyber, stopped a caravan with a militia escort, and killed five coolies employed by the M.W.S. They were then in a position to cut off water from Landi Kotal, an important post in the Khyber. The Government of India, therefore, resolved on war, and the Field Army was mobilized.

The arrangement of the forces at our disposal was:—

The N.W.F. Force, comprising three infantry divisions, on the Peshawar line, under General Sir A. Barrett.*

The Baluchistan Force, comprising one infantry division, on the Quetta line, under Lieut.-General Wapshare.

The Waziristan Force (originally part of the N.W.F. Force), under Major-General Climo.

The first problem confronting the N.W.F. Force was to clear the Khyber. This was effected in two actions on May 9th and 11th, and on the 13th Dakka, 8 miles within the Afghan border, was occupied without resistance. But a mounted reconnaissance the next day towards Basawal revealed the presence of Afghans in large numbers; these followed up the retiring cavalry, who had to charge the enemy on their way back to Dakka. The enemy then occupied a position immediately west of Dakka, from which they were dislodged the next day with heavy loss. By this time, two divisions had been concentrated between Peshawar and Dakka, and preparations were in hand for a forward move of four marches.

The Royal Air Force, though only old machines were available, carried out some important bombing raids Jallalabad was bombed on three occasions, on one of which a parade of 2,000 troops formed an excellent target. On May 24th, a R.A.F. officer bombed Kabul, and there is no doubt that this event contributed largely to inclining the Amir towards peace.

To the north, the Afghans invaded Chitral territory, where a force, consisting of an Indian battalion and the Chitrali scouts, signally defeated them and captured four guns. A later attempt, in July, to cut the communications of the Chitral force, near the Loarai Pass, was similarly defeated.

Further south, the possession of Khost gave the enemy a salient whence they could threaten our forces in the Kurram and the Tochi. They were not slow to take advantage of their position, and on May 27th advanced against Thal, occupied the city and besieged and shelled the fort and camp. The 16th Division, en route for the Khyber, was diverted to Kohat, whence, on May 31st, a relief force under Brigadier-General Dyer advanced and occupied Thal.

* Sir A. Barrett had, as a subaltern, taken part in the Second Afghan War.

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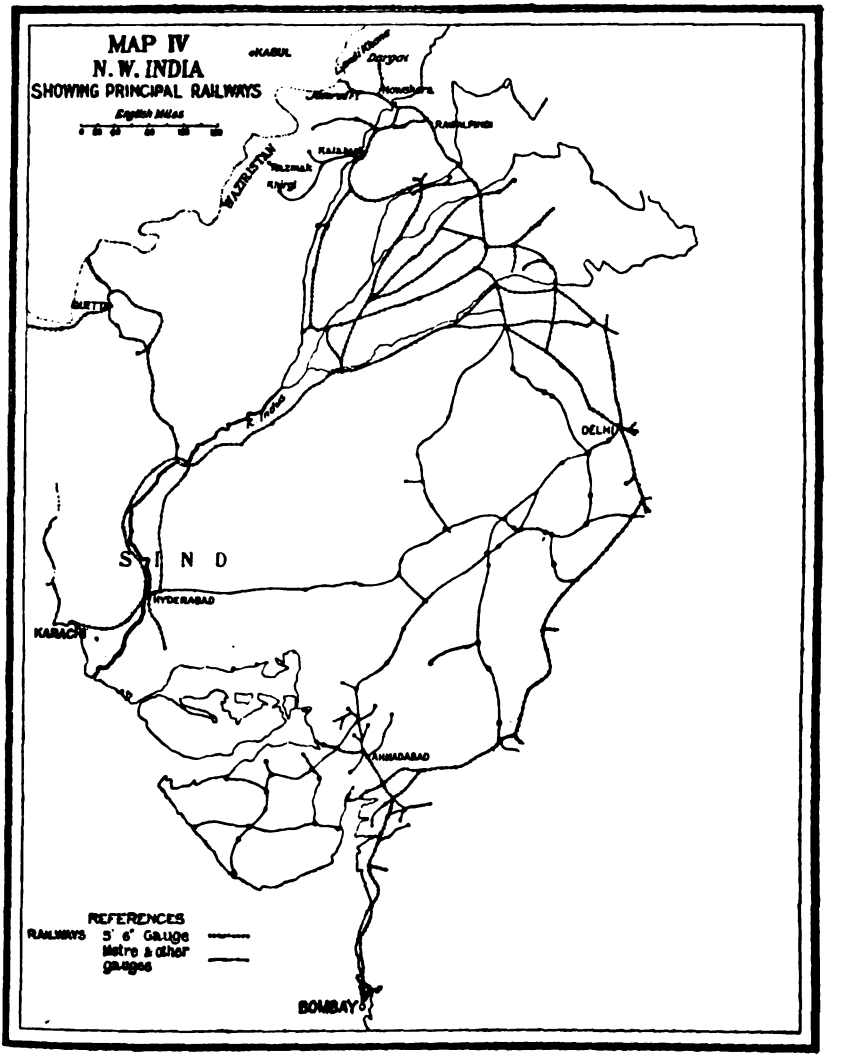
In the Waziristan area, the policy before and during the Great War had been to occupy the Tochi and certain posts in the south of the country by militia, largely recruited locally. Up to date the policy had been fairly successful, but it was feared that, should



Afghan regular troops appear in support of the Mahsuds, the loyalty of the militia would be unduly strained, and consequently orders were issued for the evacuation of the upper Tochi and Wana. The latter operation proved very difficult. The loyal remnants of the garrison reached Fort Sandeman in Baluchistan after losing 4 B.O.s

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killed and 2 wounded, out of a total of 8. Among the killed was Lieut. McCorstie (25th London Regiment), Garrison Engineer, Wana. The history of the re-occupation of the posts belongs to a later period than it is proposed to cover in this narrative.

The Baluchistan force had in front of it a hostile force of about 16 battalions and 5 regiments, with about 40,000 tribal auxiliaries. They had also an extensive area to guard where disturbances were probable. They were not strong enough in transport to undertake any considerable offensive, but had to content themselves with the capture of Fort Spin Baldak, the Afghan reply to Chaman. The fort was captured on May 27th, after an operation which reads more like a page out of Napier than any modern battle, for scaling ladders formed part of the equipment of the attackers. After 2½ hours' bombardment the fort was rushed, and of the garrison of 600 all, except 30, were killed or taken prisoner.

There was considerable danger that the Afghans would invade Zhob; Mahsuds and Sherannis did indeed cause us one of the greatest reverses ever sustained in trans-frontier warfare. They successfully attacked a convoy near Fort Sandeman, capturing two mountain guns and the greater part of the transport. When a punitive column was at last available, the tribesmen had dispersed.

The Amir sued for peace as soon as he saw that the invasion of India was not such an easy proposition as he thought. An armistice was declared on May 31st, and conditions of peace finally laid down on August 8th at Rawalpindi. They included the demarcation of the frontier in the Khyber, and the renunciation by the British Government of all control over the foreign affairs of Afghanistan.

EVENTS SINCE THE THIRD AFGHAN WAR. (*Map IV.*)

The operations in Waziristan, 1919–25, already alluded to, resulted in the establishment of a British force at Razmak, with good road communication with India. It may be said that this part of our frontier is more peaceful than ever before.

In 1928 civil war broke out in Afghanistan, resulting in the abdication of Amanullah. Order has not yet (Oct., 1929) been restored.

Note:—The Pollock Prize was founded to commemorate the services of Major-General Sir George Pollock, in the 1st Afghan war. The gold medal as now presented bears on the obverse his portrait with the words "Pollock, Cabul, 1842," and on the reverse:—

"Pollock Prize, Royal Military Academy: Founded by the British inhabitants of Calcutta, to commemorate the eminent services of Major-General Sir George Pollock, G.C.B., and awarded to the most distinguished cadet of the season."—ED. *R.E. Journal.*

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LARGE SCALE SURVEYING IN THE TROPICS.

By MAJOR S. W. KIRBY, O.B.E., M.C., R.E.

It is probable that the words "Large Scale Surveying" may convey a vision of the Ravelins at Chatham to many who have served their apprenticeship at this type of work at the S.M.E. It may, therefore, be of interest to study the problems involved and the methods employed for their solution, when such work was carried out in the field under the more difficult conditions to be found in the tropics.

It fell to my lot, when in charge of a topographical survey, to be called upon to undertake at short notice the survey on the scales of 1/2,500 (vertical interval 10 feet) and 1/360 (vertical interval 5 feet) of a number of areas varying in size from an acre or two, to a square mile. On investigation these areas, with one exception, proved to be either covered by tropical jungle or thick cultivation. In the former case the view from any spot was limited to a few yards, while in the latter, though the view was greater, it was seldom more than 50 yards. For many reasons it was impossible to clear the jungle or cultivation prior to the survey, while the completed maps had to stand the test of accuracy when the vegetation was cleared at a later date, prior to building operations.

In this particular case it was essential that each area should be in its correct position with relation to the others and to the earth's surface: in addition the contours of each had to be referred to the same datum point and had to be correct to mean sea-level within a few inches. The work, therefore, fell into four distinct portions.

(*a*) The trig. work necessary to fix the areas in their correct positions and the provision of a datum point for the heights.

(*b*) The close control within each area on which the actual survey would be based.

(*c*) The clearing of the necessary pathways in the jungle to permit the surveyor to carry out his work.

(*d*) The actual survey of detail and contours.

The methods employed for the actual survey of the areas varied with the scale adopted and the type of tropical vegetation with which each was covered. In order to prevent any delay due to surveyors being held up for lack of data or for the necessary pathways in the jungle,

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these four operations were carried out by separate parties. The first two operations were placed in charge of officers, who were also responsible for the necessary clearing work, while the fourth operation was carried out by N.C.O.s working in pairs.

There was no difficulty in making these arrangements, as I was in command of a Colonial Survey section, consisting at that period of four officers and 15 N.C.O.s engaged on a topographical survey within 40 miles of the scene of this large scale work. The necessary officers and men were, therefore, relieved from their work on the topographical survey so that each of these operations were started as it were in echelon, one behind the other, so that there was neither waste of time nor unnecessary overlapping.

The trigonometrical work and levelling. The country in which the large scale survey had to be undertaken was covered with a primary triangulation, and in those areas where topographical work was in progress this triangulation had already been broken down. The inclusion of those areas to be surveyed on the large scale presented, therefore, no serious difficulties as to triangulation, and the larger areas were supplied with two or more trig. points and the smaller ones with only one. Greater difficulty was, however, experienced with the heights. It was soon discovered that not only were the trigonometrical heights of the primary points in error locally, but that the whole system required a constant correction to bring it in true relation to mean sea-level on this part of the coast. Fortunately the neighbouring town had a bench mark established by the naval authorities whose height above mean sea-level was known. From this bench mark a line of levels was run out to those areas within reach. Some areas, however, were cut off by a mangrove swamp and areas of jungle in which any attempt at precise levelling was obviously impossible, or were situated on neighbouring islands. A line of levels was therefore run to two principal trigonometrical points and transferred from them to these areas by carefully observed reciprocal vertical angles, precautions being taken to avoid refraction errors as far as was possible.

The Close Control. Each area, having been provided with one or more trigonometrically fixed points, a starting azimuth and datum level, was encircled or split up by trigonometrical traverses. As the measurement of the legs of these traverses by surface chains or tapes was found to be too inaccurate, especially in those areas which were hilly and covered in jungle, a more up-to-date method was employed. A graduated steel tape was supported every fifty feet by means of a stake driven into the ground and subjected to a known tension. Measurements were taken to a raised mark, similar in idea to the tripods used in bases measured by Invar wire hung in a catenary, (see S.M.E. pamphlet), and allowance made for sag and

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slope. The improvement in accuracy was immediately noticeable, and over the most difficult ground with a single measurement for each leg an average closing error of only 1/9,000 was obtainable.

In the case of those areas to be surveyed on the 1/2,500 scale, the height control was carried forward by means of reciprocal vertical angles observed with a theodolite, a staff with a movable vane being used as a mark. This method, much speedier than levelling, gave an average closing error of some three inches per mile, and as no single traverse ever exceeded a mile in length this was amply accurate for the purpose in view.

In those areas to be surveyed on the scale of 1/360 which incidentally were always small, four hundred yards square or less, the height control was obtained by the usual method of levelling. In considering height control, it should be remembered that the surface of the earth in this type of country consists of some two to three feet of decaying vegetation, and is by no means a stable surface to work to. In fact, no two men working separately would produce quite the same results. It was thus obviously a waste of time to attempt to obtain rigorously accurate results.

The Clearing Operations. The cutting of pathways in the jungle to facilitate the work of the surveyor was carried out by gangs of coolies under headmen, who were experienced in the use of chain and compass. This work was supervised by the officers who were employed on the theodolite control in the near neighbourhood. It was found that three coolies could cut a three-foot pathway leaving a clean ground surface at the rate of three to four hundred yards a day, the larger trees being sidestepped, the smaller being cut down.

The Survey of Detail and Contours on the 1/2,500 *Scale.* The surveyor was supplied with the grid co-ordinates and heights of all control points within his area and, in those cases where the area was covered with jungle, a diagram of the pathways cut prior to his taking over the work. The methods employed naturally varied with the type of vegetation met with and are explained below.

(*a*) *Jungle covered country.*

Parallel pathways were cut in the jungle at an average distance apart of thirty yards, which on this scale represents 0·43 inches on paper. This distance was chosen for the reason that in jungle a view is usually obtained up to ten yards on either side of a pathway or clearing. Thus when the contours were even and straightforward they could be fixed on each pathway (every 0·43 inches apart on paper) and put in by eye over the intervening distance, while in those cases where the country was difficult they could be fixed on each pathway and at points ten yards on either side of the pathway, thus ensuring an accurate fixation every 0·14 inches on paper.

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The surveyor having plotted his grid and control on his board proceeded as follows :—

(1) He chained along the control traverse between fixed points, plotting on the board the ends of the pathways. At the same time he obtained the ground heights of the pickets left at the end of each of the pathways, using an Indian clinometer as a level in conjunction with a staff having a movable arm and graduated in feet and decimals of a foot.

(2) Using his clinometer in the same way he then moved down each pathway in turn, finding the crossing points of the contours and if necessary their location at a distance of ten yards on either flank. The heights carried through each pathway were closed on the picket at the further end and any necessary adjustment then made. If the work was carried out carefully the closing, error i na three hundred-yard-pathway was generally less than a tenth of an inch.

(3) He then surveyed each pathway with a chain, picking up the detail and the crossing points of the contours and using offsets to secure the position of pickets marking the contours on either flank.

In actuai practice the last two of these operations were carried out simultaneously, the chainmen working just behind the surveyor. The work was plotted in the field direct on to the board, so that any error could be detected immediately and corrected on the spot.

(*b*) *Country covered with tropical cultivation.*

Under these circumstances a view was generally obtainable up to fifty yards in any direction ; it was therefore unnecessary to cut any pathways. It was, however, found to be quicker and more economical to use the method explained above, ***mutatis mutandis***, than to employ *in toto* the textbook methods.

The contours were located on parallel straight lines, and on either side of these lines as far as the visibility would allow, but the average distance apart of these lines was some 70 to 100 yards, instead of the thirty normal in jungle country. In the most common type of cultivation the trees are planted in straight lines and at regular intervals ; there was, therefore, no difficulty in running the lines mentioned above without the use of a compass except in isolated cases.

The surveyor therefore proceeded as follows :—

(1) He surveyed the control traverses both for detail and to obtain the crossing points of the contours, plotting direct on to the board.

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(2) He laid out parallel lines, finding the crossing points of the contours and laying out his contours for a distance of thirty to fifty yards on either side of the line. The heights were closed on a control point at the further end. It was found more convenient to use a level in place of a clinometer for this work, since one setting of the level sufficed for laying out the whole of one or possibly two contours, whereas the clinometer had to be relevelled for each observation.

(3) He surveyed each of the straight lines with a chain, picking up the detail and contours. In those cases where the offsets to pickets denoting the position of the contours were too long, an intermediary line was surveyed. Each line was tied in position by chaining to the nearest control point. The work was done as a rule on an auxiliary board and adjusted and drawn on the fair board in camp.

In actual practice, two surveyors were usually employed on an area of this nature, and the work so arranged that operations 2 and 3 as explained above were carried out separately, the surveyor who undertook operation 3 following close behind the surveyor who undertook operation 2. This was found to produce the speediest results.

The Survey of Detail and Contours on the 1/360 *Scale.* The scale in this case being so very large, it was necessary even in this type of country to use more refined methods. The surveyor was provided with the grid co-ordinates of his control points and the height of one control point to act as datum. The methods employed varied as before with the type of vegetation and are explained below.

(*a*). *Jungle-covered country.*

Parallel pathways were cut in the jungle at an average distance apart of ten yards. This distance represented one inch on paper. In places where the country was flattish and the contours even and uniform, a point fixed every inch along the contour gave sufficient accuracy. Where the country was steep or broken, the contour was located on either side of the pathway to a distance of three yards, thus providing a fixed point on the contour every 1/3rd of an inch along its length.

The method employed was as follows :—

(1) Pickets were driven into the ground wherever one of the pathways crossed the control traverse. A line of levels starting at the datum point was run round the control traverse, fixing the heights of each of these pickets and the crossing points of any contours that happened to cut the traverse.

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(2) Using the Indian clinometer as a level (as explained earlier) the crossing points of the contours on each of the pathways were obtained and points on either side if necessary. Pickets were driven in to mark these points.

(3) All lines were then surveyed by chain and booked in the normal way.

(4) The area was then plotted in the office, taken on the ground for examination, corrected and finished in the usual manner.

(*b*) *Country covered with tropical vegetation.*

For a small area the view being more or less unlimited the normal textbook methods were employed, with the exception that the Indian clinometer was used in place of the level if the country was very steep.

Conclusion. There are two points of special interest in the procedure outlined above.

(1) The use of the Indian clinometer in place of the level for this kind of work. The value of the former lay in the fact that the country was usually so steep and the view always so limited that the normal advantages of the level were counteracted, and the lighter weight and speedier setting up of the clinometer gave it a decided advantage over its more accurate rival.

(2) The use of the grid method* for large scale work as well as for topographical work in a country covered with tropical vegetation. It is submitted that this method is the only really practical way of surveying a country of this nature on scales from 1/25,000 to 1/360. By its use the possibility of gross errors are reduced to a minimum (a check being automatically provided at frequent intervals) and within very small limits a similar standard of accuracy is obtained by different surveyors, and in addition there is no doubt as to the country being covered adequately. It should be remembered, however, that such a method is unsound for small scale work (unless severely modified) and is wasteful of effort in mountainous country.

On the whole the advantages of the method outweigh its disadvantages, and the proof of the pudding being in the eating, the successful results produced at a rate above the normal for the type of country prove that its application was sound.

* See article, "A Colonial Survey Section in Malaya, 1923-1926," *R.E. Journal*, December, 1927.

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PROPOSED NEW WAGON REPAIR DEPOT, EGYPTIAN STATE RAILWAYS, GABBARY, ALEXANDRIA.

By MAJOR D. J. MCMULLEN, R.E.

PREFACE.

THE scheme for a proposed new wagon repair depot set out on the following pages is a general scheme put forward from the point of view of the works manager.

Such details as have been found necessary from experience are specified, but, in general, the various departmental officials responsible for the provision of buildings, permanent way and track equipment, electrical equipment, and mechanical and machine tool equipment, will have to get out the details of their section of the project in accordance with the approved scheme.

Some details of the arrangement are directly due to the depot being schemed to employ Egyptian labour, but the main principles hold good for use in any country.

GENERAL NOTES.

The work that will have to be undertaken by these proposed shops is :—

(1) The 2-yearly overhaul of 8,250 equivalent 4-wheel vehicles per annum, *i.e.*, half the total wagon stock, which consists of approximately 12,570 4-wheel, 620 6-wheel, and 1,500 bogie vehicles. A 6-wheel vehicle has been taken as equal to one and a half 4-wheel vehicles, and a bogie vehicle as equal to two 4-wheel vehicles.

(2) Heavy repairs and rebuilds, such as fitting new steel floors, new steel bodies, new steel roofs, new frame members, and rebuilds after accidents to approximately 1,500 vehicles per annum, of which 1,000 are included under item (1), having come into shops for 2-yearly overhaul.

(3) Minor repairs due to accident and breakage in service, which cannot easily be carried out by outside staff, to approximately 1,750 vehicles per annum.

This gives a total 10,500 equivalent 4-wheel vehicles per annum. Allowing an average number of working days as 300, the output must be 35 vehicles per day.

Accommodation is provided in the wagon repair shops for 120 vehicles at comfortable spacing. This allows an average of just over three days per vehicle in shops.

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Actually, the normal 2-yearly overhaul takes 2 days. This consists of completely stripping off all the running gear, draw and buffing gear, and renewal or replacement of same, straightening and repairing axleguards, renewing slack rivets, patching cracked frame members, repairs to doors, fastenings and fittings. Heavy repairs and rebuilds naturally take a longer period, in varying degrees, bringing the average up to 3 days per vehicle.

The shop has, however, been laid out with a view to dealing with the maintenance of an increased stock when the extension of the railway traffic makes this necessary. There is sufficient room, handling appliances, and auxiliaries to permit of the staff working on the normal 2-yearly overhaul to be increased, so that the time for this standard operation could eventually be reduced from 2 days to 1 day, by working up to 2 squads in the place of 1. This, however, should not be necessary for many years to come.

In addition to repairing actual vehicles, these proposed shops will have to manufacture and repair, for supply to outstations, all spare parts required for the maintenance of goods vehicles in service. This supply being through Stores Dept., detail stores, except in the case of wheels and axles, are supplied in wagon loads direct to the districts concerned in exchange for worn ones.

In considering the work to be done, it has been assumed that, as at present, all drop stampings, including drawbars and buffers, would be supplied from the drop forging plant at Cairo, and that similarly all new cast steel axle boxes would be supplied from abroad finished ready for use.

No provision has been made for the manufacture in bulk of bolts and nuts, washers and rivets, as these can be more economically purchased in the open market.

The principles that have been adhered to in considering the general layout are, firstly, that all vehicles should be sorted into classes before entering shops; and that, secondly, as much as possible the movement of vehicles should be a forward progression without the necessity of frequent back shunting; and, thirdly, that ample provision must be made for dealing expeditiously and economically with the new and repaired materials and parts required daily, together with the disposal of the worn and scrap articles.

As vehicles with wooden floors and sides are gradually being scrapped and replaced by all-steel vehicles, the importance of the wood-working shops is steadily decreasing, and hence its somewhat unfavourable position in the layout.

In considering the general principles of the layout of a wagon repair depot there are 2 main systems that may be employed for collecting and sorting the vehicles for repairs, firstly by shunting and secondly by means of traversers and capstans.

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The advantages of the latter method are :—

(1) That the yard can be very much shorter than that required when all the shop roads have to be fed by turnouts.

(2) That odd vehicles can be picked out of a rake and taken at once to any point, *i.e.*, a mixed rake of vehicles can be pushed or pulled on to a traverser one by one; without previous shunting, and can be delivered individually to any desired shop line.

These advantages make distribution by traversers very suitable for locomotive and carriage shops which are only handling a comparatively small number of units of widely varying types. But for wagon repair work a traverser is not at all suitable.

Firstly, wagon stock consists of a large number of units, the majority of which are exactly similar. To sort these units into similar groups with a locomotive is therefore a comparatively simple proposition.

Secondly, the majority of lines in the shops being filled with a rake of vehicles all requiring exactly similar repairs, probably on a time process basis, it follows that all these vehicles will be completed and ready for removal at the same time. One pull with a shunting locomotive and the whole rake is removed, to be followed at once by another complete rake for repairs, pushed in from the other side.

To remove these vehicles by traverser and electric capstan and replace them with others by this method would be a longish job, as only 2 or at the most 3 vehicles could be accommodated on the traverser at one time.

When a rake of vehicles is completed at mid-day, this change over must be carried out during the dinner hour, to avoid idle time, for which operation a traverser is certainly not suitable.

In addition, the use of traverser and capstans would not enable shunting locomotives to be dispensed with, as the large number of vehicles to be handled would still need shunting for feeding on to the traverser road and for removal from same.

Provided, therefore, the necessary length of site can be obtained, no traversers should be installed, and all wagon sorting will be carried out by two electric battery shunting locomotives, each driven by one man. An electric capstan should, however, be provided at the weighbridge for use when re-taring vehicles.

General Layout.

Referring to the plan, it will be seen that this gives a schematic layout which will of necessity have to be arranged to suit the final site chosen. The same principles of layout should be adhered to, but the tracks, etc., can be curved and rearranged as may be necessary.

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The general principles of the flow of vehicles for repairs as given in this schematic layout are as follows :—

(1) A set of balloon sidings (not shown on the plan for want of space) capable of accommodating 400 vehicles plus a through road, are situated immediately outside the shops yard gate. All " cripple " vehicles for repairs will be placed in these reception and sorting sidings by the Traffic Dept., as sorted out from the incoming trains or from the various yards.

(2) The shops east yard electric shunting engine will pick up the desired number of " cripples " at the reception sidings, and after sorting them as required, will run round to the east and propel them into the shops east yard and further sort them out into the different lines of the different bays according to type of vehicle and nature of repairs.

When required these " cripples " will be propelled into their correct position in shops by this engine.

(3) It may here be mentioned that all 2-yearly overhauls will eventually be done on a time process basis.

(4) When repairs are finished, the vehicles will be withdrawn from shops by the west yard electric shunting engine, which, working up into the shunting neck provided, will sort them out into either the paint shop, the carpenters' shop, finishing shop, or straight through to the weighbridge.

Those vehicles requiring to go to the carpenters' shop will have to be pulled out again, this being the only back shunt in the system ; those passing into the paint shop and finishing shed are passed straight through to an automatic self-recording weighbridge for re-taring.

(5) After re-taring, vehicles will be collected by the east yard shunting engine and placed in the repaired vehicle departure sidings (these sidings being outside the shop gates are not shown on the plan), where they will be left at the disposal of the Traffic Dept. to withdraw at the latter's convenience.

SYSTEM OF REPAIRS.

The principle of the system of repair work is as follows :—

(1) In the wagon repair shop, which will consist of 4 wagon repair bays and 1 wheel bay, only work *actually on the vehicle* will be carried out. There will, therefore, be no fitters' benches in this shop, all bench work and manufacturing work, both fitting and machine work, will be carried out in a separate shop arranged to the north of the main building. A few vices only will be provided for holding items as may be necessary.

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(2) The only exception to this principle is the wheel-bay work, which will be carried out in the centre bay of the repair shop in order to avoid unnecessary handling of such heavy articles as wheels and axles. Similarly the eastern third of this bay will form the bogie repair shop.

In addition, in the centre bay there will be a punching and shearing machine and drilling machines to deal with patches, roofing sheets, axleguards, solebars and other members of a similar nature, all of which have to be marked off on the individual wagon. The crane runways from this centre bay will run out over a wheel park and rubbish-collecting trucks to the west and over bosh tanks, scrap bins, and "rubbish" trucks to the east.

(3) The general principle of the movement of materials and spare parts will be, that new and repaired articles will enter the shops transversely across the centre, and will be distributed longitudinally. The scrap, dirty and damaged parts will be passed out of the ends of the shop to be loaded up, or cleaned or repaired in the manufacturing shop, and then returned for service through the centre of the repair shop, or passed into detail stores for stock.

(4) The position of the stores, auxiliary, machine and fitting, smiths', carpenters' and paint shops are self explanatory.

(5) The finishing shed alongside the paint shop is merely a roofed-over space with open side for dealing with such items as box truck door rollers, runner bars, door fastenings, and petroleum tank fittings, which have possibly not been able to be completed during the time process work or which may have been overlooked in the shops and have been checked by the examining fitters.

As far as possible all work will be completed in the shops.

(6) Shunting locomotives :—

3 electric-battery shunting locomotives (to handle up to 50 empty 10-ton wagons up to 8 miles per hour and 30 up to 12 miles per hour) will be required ; 2 for service and 1 for spare.

This type of shunting locomotive is considered the best for this particular work, as, firstly, it can be worked by one man ; secondly, it does not consume any coal (or other fuel) when standing stationary ; thirdly, there is no danger of fire due to sparks while working inside shops, nor is there any smoke or dirt to foul the overhead cranes and roof ; fourthly, there would be no need for water columns with consequent mess in the yards ; and fifthly, it can be charged up at night, after shops are closed down, when the power-house load is light.

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(7) The time office will be arranged as a gate-house over the main gateway, with ticket issuing rooms to left and right below.

(8) No men's clothes cupboards will be allowed inside the shops, nor any washing. All these cupboards will be placed in two long buildings either side of the main gateway and time office, and provided with benches for taking meals and suitable washrooms. First-aid room will be provided alongside the time office.

(9) Unfiltered water will be laid on for the hydraulic system, bosh tanks, wheel press, low pressure fire hydrants, shop boilers and paint shop. Filtered water will be laid on for drinking and men's washing at the washrooms by the main gate, and for drinking purposes alongside the various lavatories, and also at the offices.

High pressure fire hydrants will be provided as necessary.

MATERIAL DISTRIBUTION SCHEME.

It is necessary, now, to consider the movement of materials, new and repaired spare parts, worn and unserviceable parts, scrap materials and rubbish, as the efficient and economical solution of this problem is the most important question to be studied.

On referring to the plan, it will be seen that the stores and manufacturing shops will be connected to the repair shop by a system of double line 18″-gauge tramways.

The modern practice in England is to replace tramways with either electric battery- or petrol-driven trolleys, either with or without trailers, and in lieu of rail tracks, suitable asphalt or concrete pathways are provided.

This method is more flexible than a rail system, but it is not considered that power-driven trolleys are so suitable for use with Egyptian workmen and labourers as is a properly-arranged tramway system.

Firstly, a trolley has to be steered as well as driven, which involves considerable skill, and of necessity a highly paid man, and even then frequent accidents.

Secondly, from experience at Gabbary, it would be very difficult to keep a clear pathway for a trolley route, as, without the ocular evidence of actual rails, the uneducated labourer and workman would be constantly dumping materials and parts on the trolley route.

Thirdly, power-driven trolleys, unless handled with great care, need considerable and expensive maintenance.

An 18″ gauge has been selected for the proposed tramway system as being more flexible than the 2-ft. gauge. The smaller gauge allows for small radius curves and shorter crossovers, and gives ample capacity for the work required.

The tramway trolleys will be of 1,000 kilos capacity, and be

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fitted with double row self-aligning S.K.F. cage ball bearings packed with grease. The trolleys will normally have a flat loading floor, but should be provided with detachable steel bins for carriage of small parts. They should also be provided with suitable detachable push handles.

Materials and parts for delivery to the repair shops will normally be taken from either the stores or the manufacturing shops by trolley through the centre of the repair shop with alternative delivery lines along the east and west ends.

Parts for repairs and second-hand materials for further use will be loaded on trolleys for return to the manufacturing shop by the return lines either from the end tracks or from the centre.

Normally, the greater portion will be brought back by the return line tramway from the east end of the repair shop, but the system is sufficiently flexible with its double line tracks and crossovers to allow for variations as may be most expedient.

The longitudinal distribution of material and parts (other than wheels and heavy items) throughout the repair shop will be effected by Morris 1-ton electric hoist blocks, with push travel, running suspended from Morris overhead runways carried from the shop columns.

Along the centre 4 rows of columns these runways will be double line, one line each side of the columns, with suitable crossovers.

Along the outer rows of columns there will be a single line runway which will be provided with suitable lie-by branches.

All these runways will be extended over the tramway tracks at the east and west ends of the repair shops.

The new material and parts will be distributed down the bays by the hoist blocks, either the individual items being slung several at a time, or the trolley bin, or possibly the complete trolley with a light load (750 kilos load, 250 kilos trolley).

Except for the outer lines the blocks will run on an up and down line system to prevent delay to one another.

The worn materials and scrap resulting from the wagons will be collected by the hoist blocks and delivered to the trolleys for disposal; if dirty or scrap, to be taken to the east end to the bosh or scrap bins; or if clean and useful, to be taken direct to the manufacturing shop either by the centre tramway or the west end line.

The reason for the necessity of the provision of longitudinal runways for the distribution and collection of materials and parts is that the repair shop will be half as long again as our existing shop, and therefore to avoid delay the overhead cranes must be used entirely for their legitimate work of lifting wagons, bogies, wheels and axles and heavy members.

All distribution of smaller articles must be carried out by the runways, thus allowing 2 cranes to suffice in each lifting bay.

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Disposal of scrap will be undertaken by the east 5-ton overhead travelling crane in the centre bay, which will work out on girders over the scrap bins and "rubbish" trucks. This crane will be provided with a magnetic grab for picking up, sorting and loading scrap, a small rotary converter being carried on the crane itself.

The west 2½-ton overhead travelling crane in the centre bay will work out on girders over the wheel park to deal with all wheels and axles. This crane will also load scrap tyres and axles into the respective "rubbish" trucks.

Rubbish and ash trucks will be provided throughout the depot on suitable dead ends to collect sweepings and ashes.

Wagon wheels and axles will be rolled by hand down the centre wheel tracks in the repair bays and the wheel bay on to special 18"-gauge wheel trolleys, and will then be pushed across transversely to the desired position, where they will be rolled off on to the wheel track concerned. Two special 18"-gauge transverse tracks will be provided across the centre of each half-bay for this service.

Complete bogies will be lifted by the overhead cranes on to the special standard-gauge transverse track provided, and then pulled across to and from the bogie repair shop by an electric capstan and suitable snatch blocks.

Outline Specifications for the Various Shop Buildings and Accessories.

(1) *General.*

In order to use economically existing steel work from Gabbary and the old Cairo locomotive shops, the buildings have been laid out with standard bays of 52 ft. span, taking overhead cranes 49' 6" span where these are to be installed.

This enables all existing cranes, shop columns, roof trusses and steel work to be used in the proposed new depot.

All rails used for standard-gauge tracks inside any of the shop buildings will be heavy tramway type section (say 90-lb. rails) bedded on concrete foundations, and all crossings, both with wheel tracks and tramway tracks, will be of the solid cast manganese steel type as used in road tramway track.

The 18"-gauge tramway track will be laid with 35-lb. rails, and where this track is inside shops or stores or runs along paved routes, these rails will be of the tramway type bedded on concrete foundations. Ordinary light Decauville tramway track is quite unsuitable for permanent shop work.

For all shops, stores and paved routes the floor-level will be ½" below the top of the rails.

The top of rails being ¼" above floor-level prevents worn tyres crushing the paving blocks, but at the same time is not enough to prevent the floor being practically flush. Floor-level also will be

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½ metre above the surrounding ground-level in order to prevent flooding during heavy rainstorms.

All roof lighting proposed will be by frosted glass to prevent entrance of direct sun rays.

(2) *Wagon Repair Shop.*

This shop will consist of 5 bays of standard shop roofing, totalling 660 ft. long by 260 ft. wide. No. 1 bay will carry one 20-ton and one 10-ton overhead travelling crane. The 20-ton crane is used for lifting coaches in case of emergency, and also loaded wagons and heavy brake vans. It has a 5-ton quick lift. No. 2 bay will carry two 10-ton cranes and the west half of this bay will be fitted with fixed hydraulic jacks for lifting the standard 23-ft. underframe 4-wheel stock.

No. 3 bay will carry at the east end a 5-ton crane, and at the centre and west end 2½-ton overhead cranes. The crane runway girders of this bay No. 3 will be extended on steel columns out over the yards as shown on the plan, 260 ft. to the east and 180 ft. to the west, suitable for running the 2½-ton crane and 5-ton crane. No. 4 bay will carry two 10-ton cranes. The whole of this bay will be fitted with fixed hydraulic jacks for lifting standard 23-ft. under-frame stock. No. 5 bay will carry two 10-ton cranes.

All cranes over the wagon repair bays, including the 20-ton, travel, traverse, and for the same maximum loading, lift at the same speeds. Thus any pair can work together lifting or carrying a wagon down the bay, and traversing vehicles on to different lines. All these cranes are provided with 5-ton quick lifts, and normally use this power. The speeds are, travel 250 ft. per min., traverse 100 ft. per min., 5-ton lift 30 ft. per min., 10-ton lift 15 ft. per min., 20-ton lift 7½ ft. per min. The 2½-ton cranes lift at 33 ft. per min.

The floor of the wagon repair shop will consist of a reinforced concrete foundation faced with treated hard wood block paving, or, as an alternative, compressed asphalt paving blocks, set in bitumen.

This wood block or asphalt block paving will be supplied and laid by experts under guarantee, as is done with street paving.

The roof of the wagon repair shop, while using the existing steel work, will be modified to give much more light and better ventilation.

Additional light will be arranged for, by installing throughout the length of each bay a band of frosted armoured glass as shown on the cross-section. The remainder of the roofing will be of corrugated asbestos cement sheeting. Continuous large armoured glass lights also will be provided on a high level along the full length of both sides of this shop. Low-level windows are useless, as the glass is always being broken by flying rivet heads, when old rivets are being cut out.

Additional ventilation during the summer will be arranged for by making 50% of the existing vertical glass lights to pivot open. These movable lights need not be controllable from below, as they will be

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definitely opened for the summer season and closed for the winter season. Efficient eaves ventilation will be provided along the sides.

Bays Nos. 1 and 2 and 4 and 5 will not end with the heavy crane girder columns, but will be carried out by a lean-to extension 16 ft. over the tramway lines.

It will be noted that only 2 wagon repair lines will be provided in each repair bay, with a central wheel track. The reason for this arrangement is that the span of the existing roof trusses does not allow of sufficient width to work satisfactorily on more than 2 lines of vehicles.

(3) *Manufacturing Machine and Fitting Shop.*

To be 2 bays of standard shop roofing 52 ft. span, 300 ft. long, with a 2½-ton overhead crane running throughout both bays.

Floor to be of wood block or compressed asphalt block paving set on concrete, as specified for the wagon repair shop.

Armoured glass windows to outer walls and suitable roof lighting and ventilation to be provided as specified for wagon repair shop.

To be divided from the smiths' shop with corrugated galvanized sheeting up to level of crane rails (behind the line of smiths' fires only).

(4) *Smiths' Shop, Spring Shop and Forge.*

To consist of one bay of standard shop roofing, 52 ft. span and 300 ft. long, separated from the machine shop as detailed above.

A cinder floor to be used and suitable eaves ventilation to be provided, also rolling doors to shut out wind and weather.

All smiths' fire hoods to exhaust into an underground flue from which the gases will be withdrawn by suction (Blackman system), thus leaving the space above the hoods free for a 2½-ton overhead travelling crane.

(5) *The remaining Shops*, not being equipped with cage controlled travelling cranes, do not need the height of the wagon repair shop, and will therefore consist of standard 52-ft. span roofing carried on steel columns, giving a clear height to the underside of the roof truss of 28 ft.

The walls, roof lighting and ventilation, will be similar to that specified for the wagon repair shop.

The second stores bay will have a 2-ton electric hoist, floor controlled, with hand travel and traverse.

The crane rails for this hoist will be extended out over the track in the stores yard to allow for loading and unloading heavy items.

The sawmill will be provided with suitable pits for underground shafting.

(6) *The Offices* will be a 2-storey brick or stone building with a plan measurement of 30 ft. by 100 ft. The shop offices will be on the ground floor, with the main office above.

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(7) *Paved Routes* with a smooth surface (asphalt or concrete) will be provided for the entrance way and along the tramway tracks.

These routes will be used for all hand barrow or trolley work, and will be available for use of electric battery or petrol trucks, should these be introduced later to facilitate handling of materials.

(8) *Boundary Walls.*

The whole depot will be enclosed by a concrete slab boundary wall, with gates over the tracks as well as at the main entrance. The storage, reception, and departure sidings are outside this boundary wall. Thus, closing the shops gates does not interfere with Traffic Dept. delivering and collecting "cripples" and repaired vehicles. The stores yard to be independently closed by an additional boundary wall.

(9) *Hydraulic Lifting Jack Installation.*

All types of E.S.R. design 10-ton 4-wheel stock (except the very old stock now being scrapped), whether the older type with angle solebars, or the later type with channel solebars, have a standard length of underframe of 23 ft., and a standard width of headstock of 8′ 9″ to 8′ 10″. As there are a total of 10,000 of these vehicles in service, they are eminently suitable for being lifted in the wagon shop repair bays by a hydraulic jack installation.

This installation should consist of duplicate electric driven pumps and accumulators feeding the jacks by suitable hydraulic mains and branches. (Pumps should have sufficient reserve capacity to supply hydraulic power to small presses, etc., as may be required in future.)

The jacks should be set in groups of 4, arranged to lift on the ends of the headstocks of the standard 10-ton 4-wheel vehicle.

The control valves should be capable of controlling all 4 jacks together or either pair independently.

There are two alternative systems available, one system has a fixed cylinder and a long ram which lowers almost to floor level when not in use, to allow vehicles to be shunted. The other system has a cylinder with its ram set above floor-level, the cylinder being hinged at its base, so that it can be laid back on to the floor about this hinge to allow vehicles to be shunted. This system involves flexible connections to the cylinder.

The actual system to be adopted should be decided after consultation with the manufacturers of these types of hydraulic plant.

As this standard 4-wheel stock is the type that in particular will be dealt with on a time process basis, it is essential that every facility should be provided in the shop to prevent any delay occurring to upset the time-table. This can be insured by using jacks for lifting the vehicles, while the runways deal with light articles of supply, and the overhead cranes deal with the heavier items. These cranes will also be available to pick up off the jacks any vehicle which may be

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found to need special repairs, and remove it to the end of the shop for shunting to the heavy repairs bay, thus not delaying the pulling out of the rake of repaired vehicles at the set time.

(10) *Electric Power* from the central Gabbary power house, 200 volts, 3 phase, 50 cycles, etc., will be laid on to all shops and offices.

Lighting of the wagon repair shop will be by gas-filled incandescent electric lamps, in parabolic enamelled reflectors, suspended from the roof trusses as shown on the cross-section.

This roof lighting will be arranged to give an intensity of illumination at floor-level of 3 to 4 foot-candles. Similar roof lighting will be employed in the other shops, and in addition each machine will have its own swivelling, shaded, 50-watt lamp.

Wall plugs for the 3-phase 12 h.p. portable electric welding plant will be provided on every 4th column in the wagon repair shop, and on every 2nd column for portable hand lamps.

(11) *Compressed Air* at 100 lb. pressure will be laid on throughout the shops to provide power for pneumatic drills, riveting and chipping hammers.

The way the air mains and branch pipes will be carried through the shops is shown on the cross-section.

It is essential that an efficient form of instantaneous coupling, of the Westinghouse type, be used between the flexible hoses and the shop air supply pipes, which coupling should be automatically air-tight without the necessity of using a spanner to screw up union nuts.

All air mains will be carried on a slight slope to a drainage point provided with a reservoir which can be periodically tapped.

The branch air pipes will be taken from the top of the air mains to ensure a supply of dry air to the pneumatic tools.

Three 75 h.p. motor-driven compressors will be installed with suitable reservoirs. Two compressors will normally be in service, with one compressor standing reserve.

SCHEDULE OF THE MACHINE TOOLS AND PLANT TO BE INSTALLED IN THE VARIOUS SHOPS.

[The details showing the principal work to be performed on these tools have been omitted for want of space. Such information, if required, can be obtained from the writer of the article direct.—ED., *R.E. Journal.*]

(1) *Machine and Fitting Shop.*

2 26″ vertical drilling machines to take up to 2¾″ diam. H.S. drills.
1 36″ radial drilling machine to take up to 2¾″ diam. H.S. drills.
1 Sensitive drilling machine to drill up to 3/16″.
1 12″ general purpose engine lathe.
1 18″ double-ended millwrights' lathe, that can be used single-ended when necessary to turn a 24-ft. wheel lathe shaft.

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3 12″ hexagon turret lathes.
1 12″ Herbert combination hexagon turret lathe.
1 Auto-lathe for making, from the bar, door rollers, door roller pins, drawbar pins and various pins, bolts and studs.
1 Plane-miller, 30″ × 30″.
1 No. 3 Parkinson horizontal miller with vertical attachment.
1 Vertical miller with 30″ diam. universal table, to take 18″ under the head.
1 36″ duplex boring and turning mill.
1 Double-headed 18″ shaper.
1 Single-headed 24″ shaper.
1 18″ slotter.
1 8″ slotter.
1 2′ 6″ Stirk planer.
3 Landis tangential screwing machines to take up to 2½″.
1 Cameron punching and shearing machine, 36″ gap.
1 Cold steel band saw.

(2) *Tool Room.*

1 Electric pyrometer furnace for hardening and tempering super high speed and high speed lathe tools up to 3″ × 1½″ section.
1 10″ precision tool room lathe.
1 Vertical drilling machine to take up to 1½″ diam. H.S. drills.
1 Universal milling cutter grinder of the latest type.
1 Oscillating Lumsden tool grinder to take up to 1″ sq. H.S. tools.
1 Heavy duty twist drill grinder to take up to 2½″ diam. drills.
1 Light twist drill grinder to take up to ¾″.
1 Heavy duty emery wheel rough tool grinder.

(3) *Smiths' Shop.*

1 Hydraulic spring buckling and stripping press.
1 Forging machine to forge rivets and bolts up to 1¼″ diam. of shank.
1 Buckton 20-ton scragging machine for testing springs for temper.
1 20-ton spring load-testing machine for testing springs for load carrying capacity and deflection.
1 36″ diam. hot saw.
2 10-cwt. Rigby type steam hammers.
1 2-ton steam hammer with oil fired furnaces for heavy forging work, and die work, for all the system and not only for the wagon repair depot. This already exists, together with waste heat boiler.
2 Boilers arranged with destructor furnaces for burning shop sweepings, sawmill scrap, and old wagon floorboards complete—1 for use and 1 spare.
3 Oil-fired furnaces for spring work, and for heating bent wagon members requiring straightening, each in conjunction with a waste heat boiler. 2 for use and 1 spare.

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(4) *Sawmill.*

1 Small general joiner and mortising machine.
1 10″ wood lathe.
1 Grit shield borer.
1 Tenoning machine.
1 36″ circular cross-cut saw.
1 36″ circular rip saw.
1 24″ circular saw with cutter attachment.
1 Band saw to take up to 2″ saws.
1 Heavy 4-cutter planing machine to take deals and baulks up to 12″ × 6″.
1 Screwing machine for re-threading old floor bolts and similar work.
1 Automatic band saw sharpening machine with circular saw attachment.
1 Circular saw gulleting machine.

(5) *Wagon Repair Shop.*

Ref. No. on plan.	
1 to 5	5 Heavy duty latest type motor-driven high production wagon wheel lathes.
6 and 7	2 Existing light Hetherington wagon wheel lathes for cutting out the tyre retaining rings.
8, 9 and 10	3 Journal lathes for re-turning and burnishing journals of axles mounted in wheels.
11	1 Axle lathe.
12	3 Tyre boring machines, 2 for use and 1 spare.
13	1 300-ton hydraulic wheel press.
14	1 " Rapidor " hack-sawing machine.
15	1 48″ heavy duty " Pels " armour-plate frame punching and shearing machine.
16	1 48″ radial drilling machine.
17 and 18	2 26″ vertical drilling machines to take up to 2$\frac{1}{4}$″ H.S. drills.
—	1 Sensitive drilling machine to take up to $\frac{3}{8}$″.

(6) *Electrical Repair Shop.*

1 Vertical drilling machine to take from $\frac{1}{16}$″ to $\frac{3}{4}$″ H.S. twist drills.
1 8″ general purpose precision lathe.
1 6″ shaper.
(Heavy work for this shop will be done in the main machine shop.)

(7) *Welding Shop.*

2 Fixed acetylene generators, each capable of feeding 4 blowpipes in simultaneous use.
2 Portable acetylene generators, each capable of feeding one blowpipe.
1 Portable 12 h.p. electric welding plant driven by an A.C. motor.

(8) *Yard.*

1 10-ton locomotive steam crane.

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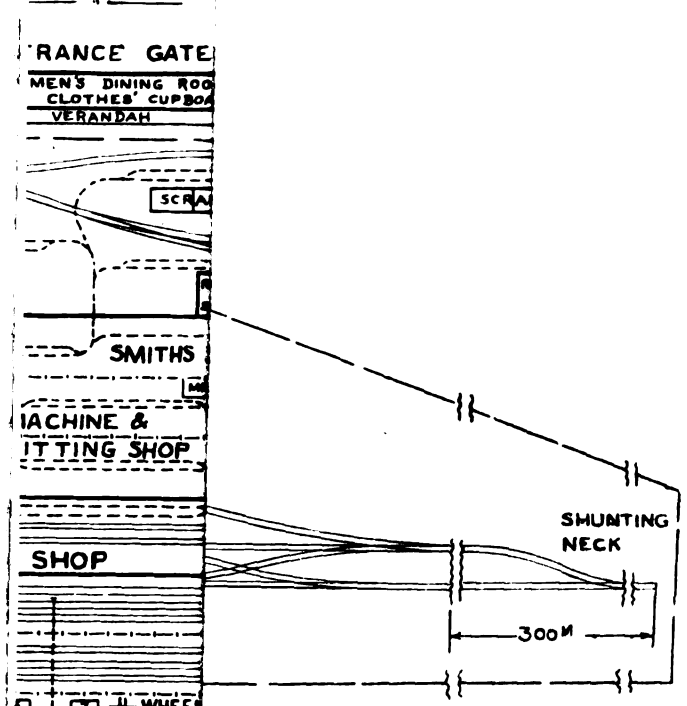

NOTES

HROUGH YARDS & SHOPS
THUS :—

SHOWN THUS :—

K SHOWN THUS:—

WN THUS :—

REFER TO LIST OF MACHINE TOOLS.

AGON OIL PURIFIER & SHOP OIL STORE.

L— LABOURERS' STORE.

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APPENDIX.

The Egyptian State Railway.

System of Maintenance and Lubrication of Goods Vehicles.

The principle on which the maintenance of goods vehicles is based is the conclusion, from experience, that a wagon should normally run for two years in service without requiring a general overhaul or any heavy repairs. While in service it must, however, be regularly oiled and examined.

Thus, on leaving shops after general overhaul, all wagons are provided with a set of six quartered 6″ diam. circles preceded by the date of completion of the overhaul and initial of shop thus :—

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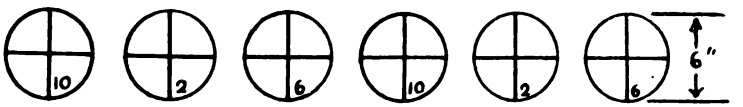

Each quarter represents one month, and the month of the year to which it refers is shown in the fourth quarter of each circle for reference.

On the completion of each month in service (*i.e.*, on the 20th, in the example given above), the wagon is oiled by the outside staff in the district it may happen to be in, and the initial of the district is stencilled in the quarter concerned, to show that the oiling has been done, and where.

On the completion of every fourth month in service, in addition to being oiled, the vehicle is periodically examined at the same time. This examination consists of removing the axle box covers and taking out the oiling pad and examining the journal and cleaning the axle box. The running gear and draw and buffing gear are also examined.

The initial of the district carrying out this examination is stencilled in the 4th quarter of the circle alongside the number of the month.

When the last quarter of the last circle is due to be marked off, the vehicle will have completed 2 years in service, and is then labelled to shops for general overhaul.

During these 2 years, all minor and light repairs required will be carried out by the various district loco. centres, the wagon being labelled as required by the examiner with a light repairs label marked to the nearest loco. centre.

In practice, it also frequently happens that vehicles are found requiring heavy repairs that cannot be carried out in the districts, and it is then necessary to send them specially to shops for these to be done, although the 2 years have not been completed. These repairs are chiefly structural either from accidents, or from the failure of old frame members due to fatigue. In addition, box trucks have to be sent to shops to be made weather-tight when roof or sides are found defective, either due to corrosion, or the effects of vibration in service.

This system of periodical oiling, examination, and repairs, ensures that each vehicle on the system gets regular and equal attention.

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THE PERSONAL CARD INDEX, OR MODERATED METHODISM.

By LIEUT. G. V. MICKLAM, R.E.

MAD we may possibly appear. Undoubtedly we are becoming more and more married. But what is wrong with our methodists? So long as we do not let our methodism run mad, we should be grateful to an unknown wit for the derisive compliment.

Far be it from us, being methodist, to suggest that we shirk work. At the same time the " in " tray of our office table is depressing to the spirit. Like the tower of Pisa, it shrieks unstable equilibrium. An ill-timed opening of the door admitting " ambient air "—in the famous words of a certain D.F.W. specification—and behold the office floor carpeted with flying fidgety feuilletons. To work, then, and reduce the pile forthwith.

Almost at once we are up against it.

" Please give full particulars of Lance-Corporal Snooks, R.E., and assess his qualifications as a bootblack, with a view to his employment with Messrs. Nugget Blossom, of Shoe Lane, Bootle."

" How many of Z Company, R.E., are recommended for instruction as officers' batmen during the field works course commencing 1/4/30?"

" Please forward the names of any men who should report sick before the General's inspection next month, if humanly possible."

Now if only we had all the details about these men at our finger tips, here and now, how quickly we could scribble off terse, well-informed, judicious recommendations. As it is, we shall have to send the papers out to the office, for Serjeant Ink to enter the rank, age, etc., of certain men, and resubmit to us. If Serjeant Ink had been cunning and helpful, like Serjeant Smart, of Q Company, he would have already tapped the vast experience of the Serjeant-Major, and have entered the names on an attached pencilled slip, ready for our humble acquiescence or scathing repudiation, according to our natures. But Ink is only a Lance of tender years—unaccustomed to handling Company Commanders.

Now supposing we had a little box on our desk, about six inches by six by four; and we could nonchalantly turn back the lid, and flick some scores of little postcards therein until we came to an alphabetical index card S; and supposing we glanced rapidly through a dozen, or less, cards immediately behind S; we could in a very few seconds have a large amount of concentrated information about

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SNOOKS, A., at our finger tips. You will remember that this was the pious hope at the beginning of the preceding paragraph.

The card might look like this :—

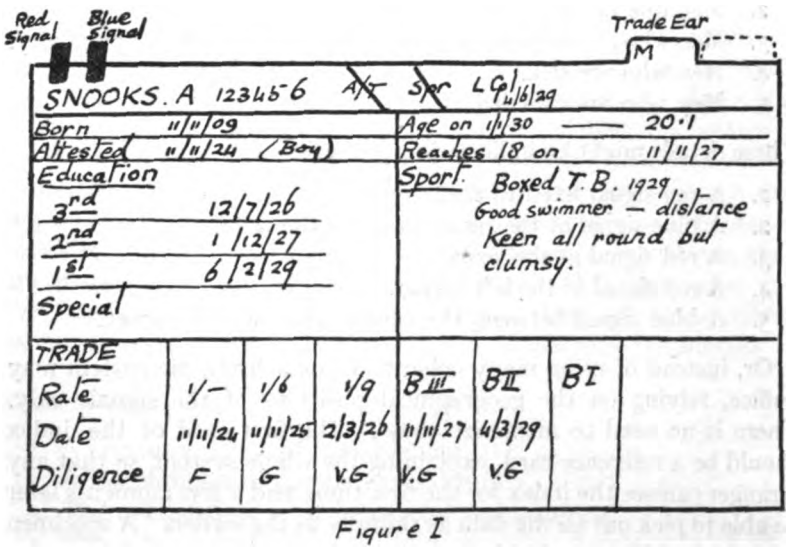

Figure I

and the Company Commander makes notes about the man's character etc., on the back of the card, if required.

The writing on the card gives certain information about the individual. The little gadgets at the top of the card fulfil the additional object of registering general information about the Company, apart from individuals. Let us introduce them.

Trade Ear. These are projections from the card itself, and bear the initial letter of the man's trade. We know at once that Snooks is one of our masons. The ears of the bricklayers stick out a little further towards the side of the card, and are labelled B. They are shown dotted in the sketch. Owing to their geographical position they form two lines of ears from back to front of the box—one line of masons, and one line of bricklayers. Consequently, by simply running a finger along the cards from back to front of the box, we can discover the numbers of each trade on the strength of the Company at any particular moment. In a school of instruction where one officer deals with, say, only five trades, this might be the best system. In a Field Company, where trades are numerous, the system needs modification. The principle holds good in all cases, but it rests with the officer to apply it to his best advantage.

Signals. These are commercial articles, consisting of small coloured metal clips, which can be attached to the top edge of a card, and stand out like guides. They occupy a width of approximately $\frac{1}{8}$" on the card.

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Now supposing we want to record a set of data such as the following :—

1. Men overdue on their trade tests.
2. Men due in current month for discharge.
3. Men who should come up to the office at the first opportunity.
4. Men who are sick.
5. Men who are married.

These details might be indicated as follows.—

1. A red signal fixed to their trade tab.
2. A blue signal at the right corner of the card.
3. A red signal at the centre.
4. A red signal at the left corner.
5. A blue signal between the centre and the left corner.

Or, instead of using many colours, a monochromatic system may suffice, relying on the geographical positions of the signals only. There is no need to memorize these. The first card of the index should be a reference card, explaining the whole system, so that any stranger can see the index for the first time, and a few moments later be able to pick out all the data as skilfully as the owner. A specimen reference card is sketched below, with all its signals in position.

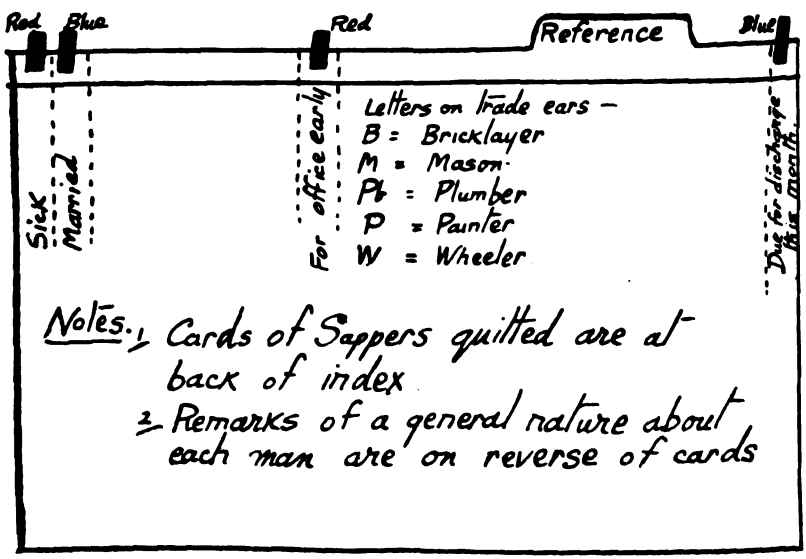

Figure II

Let it be emphasized that the preparation of such an index of 200 cards is not very laborious. We can buy enough postcards for a shilling to form a considerable encyclopædia of our company, class,

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school, or even platoon. Our nephew, fresh from his geometry at St. Wellingchester's, will draw all the requisite lines nearly in the right places, for the humble half-crown. And we are perfectly justified in arranging for Serjeant Ink to fill in most of the particulars, in Government time, because this index will, we know, save incalculably more Government time in the future. Yes, bearing this in mind, we might perhaps ask for next Thursday off, after all. The open meeting is always a great success, and we have a shining new brassie—one with a heavy head, but beautifully balanced. One might even carry that tree at the tenth, and the moat will not cause us the slightest—er—as we were saying, it is a good idea, this card index business. Once it is completed, further alterations, promotions, etc., are quickly and easily recorded, for all time. Well then, what are the disadvantages of our system? When these are propounded, we can pass on with a clear conscience to tabulate the advantages.

Disadvantages.

1. A certain amount of initial labour.
2. A few shillings of private expenditure.
3. The compilation must be careful and accurate.
4. The index must be kept up-to-date. This, however, is an easy matter, and occupies only a very few minutes each day, which must not be grudged.
5. Loose cards may be lost.

Advantages.

1. Details of any individual are available at very short notice—as in a telephone call.
2. General information about the whole unit can be quickly seen, without scrutinizing the detail of each card, *e.g.*, how many men sick, how many married, how many masons can be spared to-day.
3. Any fresh information about anyone can be recorded for all time, before the correspondence is filed away and forgotten.
4. Infinite expandibility.
5. Making up a suitable card only requires common sense, and no specialized business training whatever.
6. Handing over to a newcomer is simplified.
7. No disorganization if the O.C. is a sudden casualty, as the next senior can take over all the information at once, and need not delay the office by countless questions.
8. Cards not wanted can be relegated to the "dead" part of the index, yet they can be resurrected, as when a Sapper rejoins a unit after absence. "Live" information is not mixed with "dead."

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The whole attribute of a sound card index scheme is simplicity. And therefore a word of warning to the enthusiastic "signaller" would not be out of place. Let him put this question to himself before the little coloured signals lure him on to complexity. "Am I putting in relevant information which is likely to be of constant use to me? Or am I letting my methodism run riot? Shall I need this information once a day, once a month, once a year, or once in a blue moon?" When blue moons come into the question, the index is his master, not his servant.

Let him remember the next owner of his little box, and not make it a box of tricks. For here is the card of a Sapper

who is a bricklayer,
who is overdue on his trade test,
who has a third-class certificate,
whose boots do not fit,
who has had lockjaw,
who is undersize and overweight,
who cannot swim,
who is in No. 1 Section,
and No 3 Barrack Room,
who is a chess champion,
and whose greatcoat is due for condemning.

In fact, his card betrays him fully as a remarkable fellow. Heaven eserve us from having him as our C.S.M. one day.

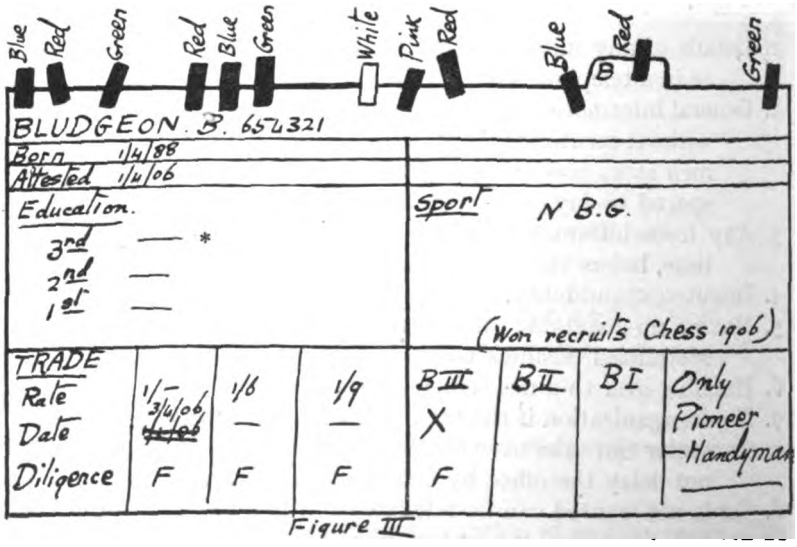

Figure III

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REINFORCED CONCRETE SWIMMING POOL, SHANGHAI.

By LIEUT. J. E. C. MCCANDLISH, R.E.

THE moist heat of Shanghai makes facilities for bathing very desirable. No sane person, having once inspected the local river, the Whangpoo, or creeks, would dream of immersing himself voluntarily in any of them, and, as the existing resources in the way of swimming baths for troops were inadequate, permission was received from the War Office at the end of March, 1928, to construct a bath at a cost of £650.

There are in Shanghai a number of baths, owned by the Municipality and various clubs. Arrangements were made in 1927 for the former to be allotted at certain hours to the troops. In addition, the British Forces Recreation Centres, a voluntary organization which ran canteens, built a small bath which was very popular.

The site chosen for the bath now described is on municipal property, in a corner of Yu Yuen Road Camp, which is built on ground earmarked for a school for boys and close to a girls' school. The funds available proved the deciding factor as to size, and a bath 70 ft. by 30 ft. was designed. A depth of water ranging from 6 ft. 6 in. at one end to 4 ft. at the other was considered sufficient to allow for a certain amount of high diving and for water polo. The level of the water is 6 in. below the edge of the bath ; this figure might have been increased with advantage, as there is a good deal of spilling when the bath is full of men.

In the words of the journalists, Shanghai is a city built on a swamp, and while that is not strictly true, in that the ground was all cultivated before it was built over, there is very little rise from the sea-level ; in this case water was found about 3 ft. below ground-level. (See Fig. 1). The creek into which the bath drains is tidal, in which respect it conforms to nearly all the creeks by which Shanghai is intersected ; many of them are culverted and have roads built over them. Draining into this creek was found more practicable than laying a longer line into a road drain at the same level, or cutting up asphalted tennis courts in the girls' school grounds.

This question of drainage necessitated the top of the bath being raised above ground-level ; it was found possible, after giving our drain a drop of 12 inches in its length (350 feet), approximately to balance the cut and fill. In rainy weather, or when the river is in flood, this 12-inch drop will be reduced by about a half.

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The design of reinforced concrete bath to meet these conditions, where the whole of the surrounding earth may be at times water-logged, presented some difficulty to one who lays no claim to be an expert. The *S.M.E. Manual*, which in most reinforced construction work supplies the correct answer to anyone who will follow the sequence of calculations, did not serve quite as well the special requirements of the case.

The design is admittedly too strong, but it was preferred to err on the lavish side in view of the uncertainty of the behaviour of the ground and the lack of knowledge of the efficiency of the contractor, the cement, and the reinforcing steel. The floor was doubly reinforced in view of the probability of the surrounding ground sometimes becoming completely waterlogged. This did happen in 1927, and the occupants of the camp had to wade to and from their meals.

The embankment walls are not to be relied on to support the walls of the bath to any appreciable extent, as it will be months before the made ground will set.

The contractor, after an initial reluctance to space his reinforcing meshes in the floor slab, which had to be corrected somewhat forcibly by the A.E. at an unholy hour on a Sunday morning, proved himself able and efficient.

The methods of contracting and sub-contracting in the city are complicated. We placed three orders, one on a European firm for the water supply (the Chinese are neither adept nor competent at this work), one for the matshed covering and bamboo fencing (contractors for this work being a special race), and one for the remainder of the work with a Chinese contractor.

The latter then let out to separate sub-contractors the drainage, the excavation, the steelwork, the concrete, the supply of carpenters, the timber, and the painting. This ensures experts at every particular trade, but provides the contractor with an excellent excuse for "passing the buck" if anything goes wrong.

The excavation was done somewhat slowly, the day's work of a coolie (9 hours) being only about 75 cubic feet, the soil being exceedingly easy, the excavating tool universally employed is as shown in Fig. 2.

Water was found where anticipated, and drains leading to a sump were dug, a pump was produced and, being Chinese, it is needless to say it would not, at first, work.

The network for both the floors and walls were tied together quite neatly, but great difficulty was experienced in making the contractor understand that it mattered where the steelwork should be placed in the concrete.

The concrete was mixed entirely by hand and provided an astonishing example of the efficiency of gang labour well organized. A batch of 1 : 2 : 4 concrete with four feet of stones averaged just

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under six minutes for mixing and pouring; this speed was kept up indefinitely.

The gang was composed of eighteen men. Four men (in two pairs) carried the sand and the stone, two other men filling their measures at the dumps, two more uncrated, sieved and carried the cement, four men mixed and poured, and two men watered. Two men rammed

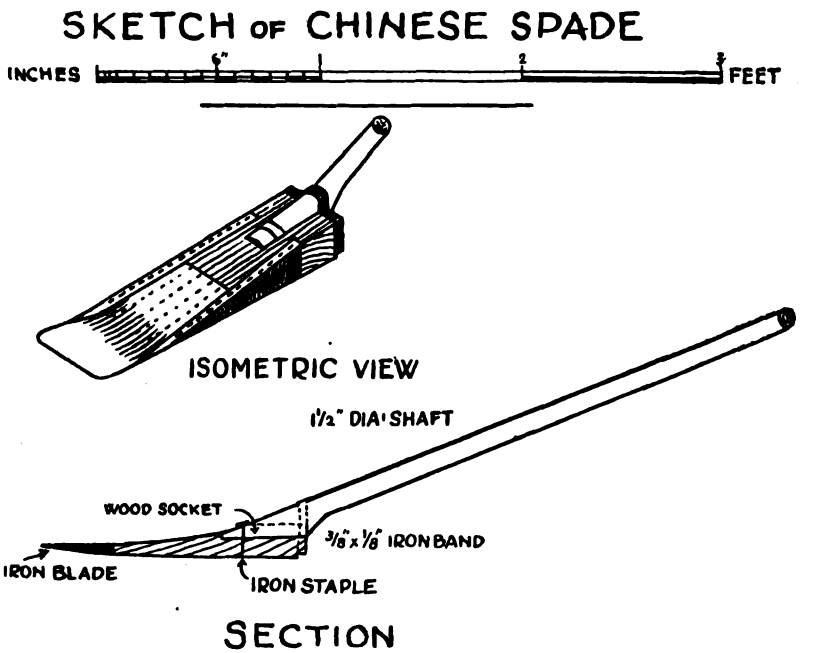

FIG. 2

and shovelled the concrete into place; there were at least two men spare. Each man could take any other man's place, and the gang worked up to 12 hours a day without any break, except for one man at a time sitting out smoking a cigarette.

Carpentry was as usual well done, for with few tools the Chinese can work wonders. The only peculiarities are that nearly all planing is done with a short-handled axe, and all sawing with a fretsaw.

It is impossible to get seasoned timber in any quantity in Shanghai; practically all the wood is newly imported American. Except for special work, we have used Oregon pine for all our hutting, and have

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had considerable difficulty in getting reasonably sound material. The writer has made a rule that any rejected timber must be taken off the work immediately; if found next day a large wedge is cut out of it, thus reducing the contractor's chance of using it elsewhere.

We have found Solignum excellent as a preservative, and stain for wood; it will be necessary to give all exposed woodwork one coat every year. The drawback is that when applied in hot weather it takes a long time to dry. The material is not very satisfactory in any but the natural brown colours.

The design of changing-rooms was adopted to ensure men having a shower before going into the bath, to keep the water from dirtying too quickly. A springboard and a small high-diving platform have been added, and electric lighting installed over the bath and in the changing-room.

The construction of matsheds which form the roof of the bath and changing-room is a fascinating art. In all but the very biggest of them (*e.g.*, our hangars, which were 70 feet wide) bamboos form the only support. Men engaged on the construction are specialists all their lives, and know by instinct the size of bamboo required and the design of truss needed. All that is required is to give the ground dimensions and the height you want, and the matshed contractor does the rest; barring a typhoon they never fail.

The joints are tied with approximately square lashings of dried reed about 1/8 in. by 1/32 in., and the covering is of mats made of the same material laced together; usually a roof consists of two layers of these mats with a sheet of oiled paper between them. The roof will need repairs after about six months, and renewal before a year, but the framework, including the reed joints, seems to stand indefinitely.

The usual practice is for the contractor to remain the owner of the material and either to remove it, or be given an order to renew the roof, after about six months. With these conditions, they cost little over 1½d. per foot super for small sheds, and about 6d. for very large ones.

The diary of the work is as follows: the contract was placed on April 24th, for completion within six weeks. Four days later, after the outline of the bath had been marked in powdered lime, the excavation was started. This took five days, on one of which there was considerable rain. Rain stops work almost entirely, as the labourer, having but one suit of clothes, prefers to stay at home and earn no money rather than get it wet.

At the same time that the excavation was going on, the matshed over the bath was constructed, so making work possible during showers.

On the thirteenth day, concreting the floor started, the interval having been occupied with placing shuttering and steel mesh. The

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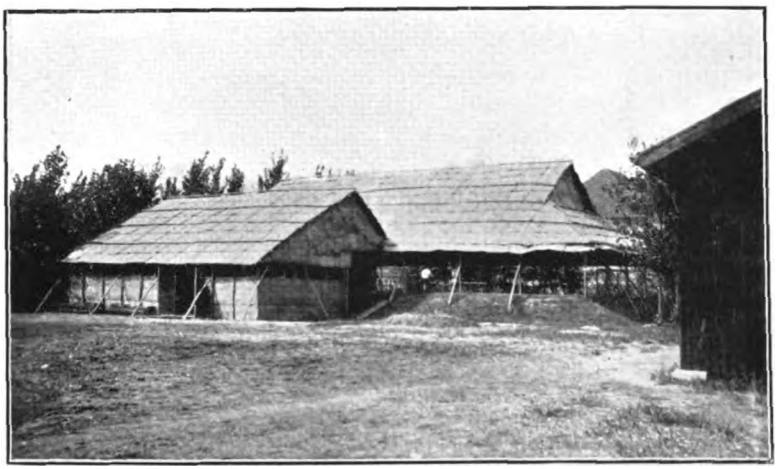
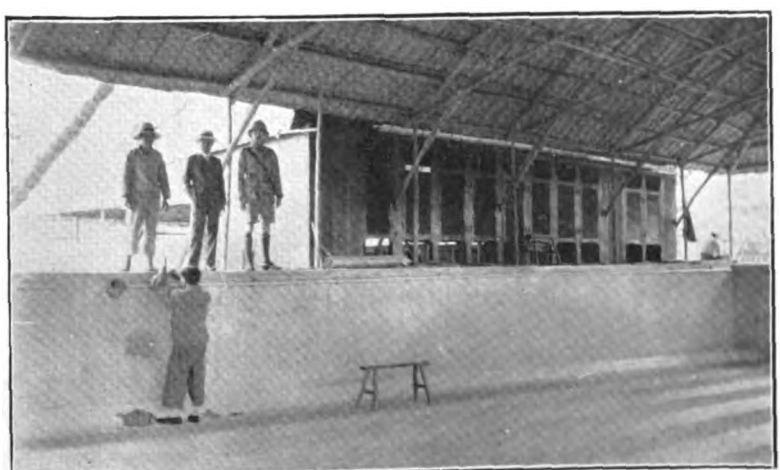
REINFORCED CONCRETE SWIMMING POOL, SHANGHAI.



Mat Sheds Forming Roof of Bath.



Interior, Showing Dressing Rooms.

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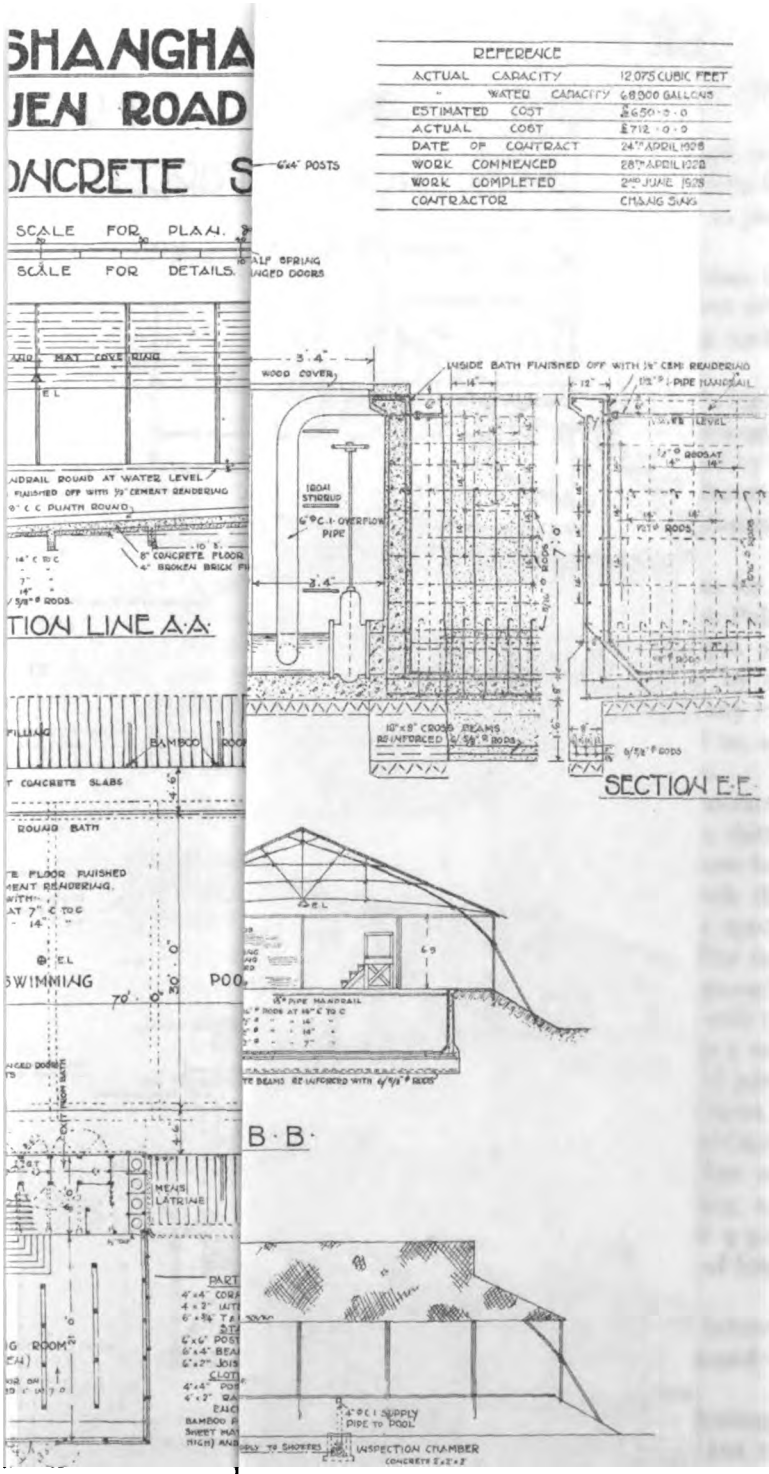

REFERENCE	
ACTUAL CAPACITY	12,075 CUBIC FEET
" WATER CAPACITY	68,800 GALLONS
ESTIMATED COST	£650·0·0
ACTUAL COST	£712·0·0
DATE OF CONTRACT	24TH APRIL 1928
WORK COMMENCED	28TH APRIL 1928
WORK COMPLETED	2ND JUNE 1928
CONTRACTOR	CHANG SING

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floor, which contained 55 cubic yards, was poured in two days, each of 12 hours' work, with one gang mixing. In four more days the sides of the bath were finished, and the shuttering was left in place for a week.

The carpentry work for the dressing-rooms was started when the carpenters had finished work on the shuttering, and progressed without incidents other than the fury of the A.E. on discovering timber with large knots.

The drainage was laid out with great difficulty by means of a highly inaccurate level. This instrument was sent out with the Shanghai Defence Force. The accuracy thereof has not been improved by its use for trade tests of instrument makers, for whom it is deliberately thrown out of adjustment, and through whose efforts confusion is worse confounded.

Salt-glazed pipes are almost unknown, and for this job, as for all other of our drainage works, concrete pipes were used. The Public Works Department manufacture very good concrete pipes and gullies, etc., and these are copied in an inferior manner by the Chinese. Drainage work is consequently, if not nasty, at any rate indifferent, but it is cheap, the 9-in. drain for this bath laid on, and bedded in hard core costing 23s. per chang, *i.e.*, ten foot run.

In this case, the operation was prolonged by the drainage contractor being " difficult," and the drains were not tested until the thirty-second day. The floor of the dressing-rooms, which had been held up, was laid three days later. The G.O.C. visited the work that day, much to the joy of the contractor, who turned on a special demonstration gang of concrete mixers for his benefit. The contractor finally cleared off the site on the fortieth day, two days early.

The water supply was started on the twenty-third day, and the main pipe line was tested on the thirtieth day. The job was a very simple one, and calls for no comment except the number of joints which had to be remade. It is rather curious to note that most of the plumbers in Shanghai come from Canton, and the South of China. The pressure at the main rarely exceeds 30 lb., and the line was tested to 140 lb. The main pressure is obtained by pumping, and the problem of filling the bath in permitted hours, between 9 p.m. and 5 a.m., was somewhat urgent. In order to reduce loss of head, a six-inch meter was installed on the 4-in. main.

It has been found that the delivery at the bath varies between 300 and 190 gallons per minute, according to the other demand on the main.

The original liability for the bath was £470, excluding drainage, the matshed cover £36, and the water supply £100 extra, but the movement in exchange between the tael (the currency in which all works are done) and sterling went the wrong way to the extent of about 12 %, so that the final cost was just over £700.

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MAP READING RACES.

By LIEUT. W. L. ROLLESTON, R.E.

IN the event of war a great many sappers would at once become N.C.O.s, and perhaps more in our Corps than elsewhere, the junior N.C.O. would have to be able to read a map accurately and quickly. Map reading is, therefore, an important part of the military training of the sapper, but it is a difficult subject to teach, especially by word of mouth.

This is a short account of a method of teaching practical map reading, which has been used with some success in a small unit this training season. It has no claim to originality—many of us have done wild schemes of the same kind on bicycles at the Shop—but it does not seem to be in very general use at present. The idea has been adopted by some of the local infantry, who have become quite keen about it.

The scheme is run on the lines of a " treasure hunt," the men being divided into about four parties, each with a serial number. It was found better not to include senior N.C.O.s, so as to make sure that the younger men could air their views. A one-inch gridded map, protractor, and prismatic compass if possible, should be carried by the N.C.O. or sapper in charge of each party. Envelopes containing the first clue are given out in barracks, and all are started off together.

The first point is usually indicated by a simple four-figure map reference, each squad, of course, getting a different place to find. The next clue is there, hidden in a fairly large envelope. As a four-figure reference indicates only a square of 100-metre sides, this square has to be accurately located and thoroughly searched. The second clue may be a magnetic bearing with a distance in yards, and the syndicate can either try their luck with compass marching, or set out the bearing with a protractor and locate the spot on the map. The latter is more accurate for a distance greater than a few hundred yards, but the compass provides a useful check.

The next envelope when found may contain a straightforward map reference, or possibly a grid bearing with a distance; and again the search continues. The final point should be the same for all, and made fairly difficult to find. The time of arrival of each party should be noted, and all clues handed in and checked to avoid " short cuts." The first lot to finish are suitably rewarded, perhaps excused the next

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marching order parade, and all are made to complete the course before being allowed to return to barracks.

The preparation requires some care, as details may easily go wrong. Four or five suitable points should be chosen on the map and lettered. They should be roughly on a circle which includes the starting point. The parties should be sent round in opposite directions with different first points for each. The points can then be juggled about till all the routes are of about the same length. Large envelopes for each point and the finish should have their distinguishing letter outside, and the clues can then be worked out and put in smaller envelopes inside the large ones. Each small envelope must bear the serial number of the party clearly written on it. It is a good plan to get someone to follow each route round on paper as a check, especially of the bearings. On the morning of the scheme the circle must be followed round by car or bicycle, and the big envelopes hidden at the various points. They should be well concealed, both to make the scheme more difficult, and to evade the curiosity of village children.

The schemes can be made progressively harder, and various interesting features added as the standard of map reading increases. Conventional signs make useful clues with just enough surrounding detail to identify them, and considerable amusement can be got by thinking out tricky places of this nature.

The actual points can be well concealed, and may call for ingenuity as well as map-reading skill. One finishing point given as a map reference was the window sill of an old passage window ; the passage ran along the inner side of a grass moat, and was about twenty feet from the ground. The entrance to the passage was locked, and a ladder concealed some distance away. It was a close finish, and two parties arrived at the point almost together. One lot located the envelope, found the ladder, and got the envelope down in under four minutes from their arrival, which was fast going.

The sappers got extremely keen about these " races," and learnt a good deal without knowing it. The much-discussed quality of individuality was apparently also developed as the following incident shows. A party was leading comfortably on one occasion near the finish, when they were passed by another lot who had adopted the simple expedient of taking a bus !

It is probable that this kind of scheme is in use in a great many units with variations and improvements, but to those which have not already adopted it, it can be strongly recommended, both for training and amusement.

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"ILEX" IN THE FASTNET RACE.

By ONE OF THE CREW.

IN the year 1926, one of the crew made his way round the Fastnet course for the second time, and for the second time vowed it was his last race. As he stood on Mizzen Head in August, 1927, watching the great white-crested Atlantic rollers smothering the Fastnet Rock with spray, he vowed that his luck was in. As he read the account of the 1928 race, prepared to gloat over the tribulations of his brother officer, he was troubled. *Ilex's* luck was unquestionably out. It must be restored, and that necessitated a mascot. One of the crew must produce a mascot. There followed correspondence, persuasive on one side, almost illegible on the other, between himself on the one hand and the oldest R.E. ocean racer on the other. Josh must go—too old—nonsense—too busy—nonsense—not enough olives—nonsense—I have to take a cure—You won't need it after the race—Alright, I'll go, but by heck you will go, too, one of the crew, that when the waters are troubled and ocean racing gives me a pain I may feast my eyes upon your physical infirmities and my spirit may be gladdened by the spectacle. And so it came to pass.

On August 13th, after listening to a fortnight of (apparently) howling gales and meditating what excuse I could produce for going sick at the last moment, I leapt in a smart and seaman-like manner on to *Ilex's* deck from Cowes pier. *Ilex* left the pier immediately, leaving my curiously assorted baggage thereon surrounded by the inquiring offspring of innumerable trippers. The result was a re-disembarkation *via* the dinghy with the Mascot, who was only too pleased to get ashore to supplement what he considered to be the inadequate victualling of the ship for the voyage. The Mascot did us well. An enormous melon he bought from a smooth-tongued widow, who assured him that it was ready for immediate consumption. It was over-ready. It was bad. A goodly supply of hot-house grapes we bought and other delicacies. 1929 was going to be a bumper year. We came to the more solid items remaining to be purchased. Kippers, salted silverside of beef, onions. The Mascot paused. "We must be returning to the ship," he murmured. "Can't let the others do all the work. What about *you* sleeping ashore, and collecting these remaining items to-morrow?" It is no use arguing with a mascot. We returned.

Ilex had been anchored in a most masterly fashion. We were

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obviously foul of not one but two smart motor cruisers. As we swung on our chain, first we threatened one of them, whereat the apparently deserted vessel sprang to life and a hand appeared with a fender and a scowl. Then we came round, making as if to board the second, and a chef thereon would look threatening. On *Ilex* no one moved. It was too obvious that we would have to move vigorously in the near future, so why budge until we had to? Francis, who had spent the last three-quarters of an hour coiling down and putting the sail covers on, was below. He was obviously the person to take them all off again. At last—"Up mizzen and stay-sail, break out the anchor." Slowly we moved off, looking for a berth. When we were just beginning to wonder when we would find one, a good samaritan on *Avocet* sent his launch to tell us of a vacant mooring and tow us to it. Once more peace reigned—except for Francis quietly coiling up all the ropes and putting the sail covers on again.

The Mascot and I then had leisure to count the crew. One, two, three, four, five, plus the cook. We started tactful enquiries. Yes, the crew had dwindled to five. Five, one of whom had not pulled a rope for two years, to represent the Corps in the big cruiser event of the year, against a highly enthusiastic band of experienced cruising yachtsmen. Leave difficulties, alas, had reduced us to this sorry plight. Luckily there was a ray of hope, or rather two distinct rays. The immediate ray was directed towards the neighbouring yacht *Avocet*, which was supposed to be crawling with Sapper subalterns probably at this moment reclining in deck chairs in comfort, pitying the poor victims on *Ilex*. An attempt must undoubtedly be made to shanghai them. Wilks and I were deputed to make the attempt, the former presumably with an eye to the possible use of physical force. We rowed off to *Avocet*, where we were most hospitably received, and returned half an hour later considerably cheered internally but without any additions to our crew. *Avocet* was about to sail on a shaking down cruise prior to the Santander race.

The second ray of hope was that Fryer and Gibson, who had been wired to, might obtain the necessary leave and join us before the race started. Fryer arrived by the last boat on Tuesday night. There was just a hope that Gibson, who was returning home from Belgium that night, would join us before the start on Wednesday morning.

After our unsuccessful visit to *Avocet* we adjourned ashore for dinner, thence to the hospitality of the Royal London Yacht Club, where those who indulge in Fastnet racing are wont to foregather and get their sailing instructions. It is becoming an unwritten law of the R.E.Y.C. in the Fastnet race that the crew of *Ilex* obtain the handicaps by hailing one of our rivals after the start—they never seem to be obtainable with the sailing instructions.

On Wednesday morning Gibson arrived. Under the circumstances

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we had hardly expected to see him, but thanks to the sporting action of the authorities in providing the necessary leave at a moment's notice and his own great keenness, he had achieved the apparently impossible.

Ten a.m., therefore, saw us cruising about before the start in a light breeze under jib, main and jackyarder, with the jib topsail in stops and spinnaker and reaching foresail ready to hoist.

We got a very fair start at 11.30 a.m. with the wind dead aft and ran for the Spithead forts. It is curious that the order of start has given a very fair indication of the order of finish in the three races I have been on. In this race we were close astern of *Neptune*, *Jolie Brise* and *Maitenes II* as we crossed the line, with *Saladin* abeam and close inshore. The rest of the fleet were tailing out astern. *Neptune* gave up, *Jolie Brise* won, and *Maitenes*, *Saladin* and *Ilex* kept reasonably close company throughout the race. The rest of the fleet we lost sight of after the first day.

The crew had not begun to settle down yet. Watches had not been fixed and all those members of the crew not actively occupied lay on deck watching the fleet. The sole exception was the indefatigable Francis, immediately nicknamed the Busy Bee, who had taken on the duty of wireless operator. This duty included that of getting one or both of our two sets to work, prior to our getting time signals and light music. Francis started by taking exception to our horizontally-wired frame aerial. In this he was unquestionably correct, as the results with it were *nil*. He immediately proceeded with the manufacture of a frame and the winding thereon of two hundred feet of wire in some thirty coils, each being threaded through four holes in the frame. After the first gybe he was found looking at some wreckage which had apparently been hit by a shell, but which actually had felt the weight of either the boom or Wilkinson's foot. In a disgust too deep for words, he disappeared below, to re-emerge with a new frame and restart the winding of the aerial. His patience was rewarded by obtaining time signals and weather reports throughout most of the race.

Close to the forts we ran into the " twelves " racing close-hauled, and *Neptune* obliged with the first touch of humour of the race in the form of a nice gybe all standing, while trying to avoid them. Luckily there was little weight in the wind. Spinnakers were taken in rounding the forts, and the long spell of tide dodging and beating in light and fluky winds which lasted from Spithead to the Longships began. Under such conditions Chance plays too great a part in relation to skill. Luck, in the shape of a patch of breeze, took the tail of the fleet past us shortly after rounding the forts. Lucky breezes enabled *Maitenes* and ourselves to pass and repass each other more than once *en route* for the Longships. Luck enabled us to catch a faint breeze across Mount's Bay which took us up to the leaders at the Runnel-

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stone, and luck gave *Saladin* a fair wind into Plymouth which died away to leave *Maitenes* on the doormat. However, it is all in the game, and without the element of luck a race like the Fastnet race for yachts of an infinite variety of design would probably lose its chief charm.

Near St. Catherines, *Saladin*, tired of tide dodging, headed a large contingent out to sea, leaving *Neptune*, *Jolie Brise*, *Maitenes* and *Ilex* dodging along the coast in that order. About two miles separated *Neptune* and *Ilex*.

During Wednesday night the wind shifted northerly and freshened slightly. *Ilex* hoisted yankee jib and reaching foresail and bowled along merrily. By dawn on Thursday, *Maitenes* was astern and *Neptune* and *Jolie Brise* were still in view ahead.

Thursday was a repetition of Wednesday, with light airs from varying directions, all four boats hugging the shore. *Maitenes* passed *Ilex*, was in turn repassed, and passed us again to end the day about a mile ahead. The two leading yachts continued to open out a lead, but were still in sight. Of the *Saladin* contingent there was no sign. At nightfall, the Eddystone Light was about a mile away on the starboard bow.

Thursday night was a good illustration of ocean racing in light airs. The wind shifting astern spinnaker was set to port at 1 a.m. The 2–8 a.m. watch (we kept two watches of three) gybed ship in the pitch dark at 3 a.m. and in all took in spinnaker, gybed and reset spinnaker three times to catch the varying airs.

At dawn on Friday we approached the Lizard with the three leading yachts rather closer as a reward for the night's exertions. As the visibility improved we sighted a stranger under spinnaker on the port quarter, which proved to be *Saladin*. Thus the much debated question as to whether the fuss and bother of tide dodging down the coast in light airs pays against the bold policy of getting right out into the channel remains a very open one. In 1926, *Ilex* made for open water, and it paid handsomely. This year we tide dodged. Did it pay? *Quien sabe?* At any rate we did not lose much by it. Heading for the Runnelstone Hunt greatly improved our position by keeping out of Mount's Bay, while the three leading ships went in and lost the breeze. Passing the Longships we were close astern of *Neptune* and *Jolie Brise*, and had opened out a lead of about a mile on *Maitenes*.

The second phase of the race begins here with a leg N.W. to the Fastnet Rock, tide dodging behind us *pro tem.*, and a breeze freshening and veering rapidly. By 10 a.m. we were nearly close-hauled and thumping into a troublesome short sea *en route* for Ireland. The ship was getting thoroughly wet and the lee rail was awash. She was being hard driven in the endeavour to prevent *Jolie* and *Neptune* getting away, but weight was bound to tell under the existing con-

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ditions. We stuck to our jackyarder yankee jib and reaching foresail to the bitter end, the crested tops of the waves sweeping the decks from end to end, sheets of spray drumming on our oilskins. *Jolie Brise* made the first move in reducing sail. Down came her yankee jib and up went a small jib topsail. We followed suit. The next move was also by *Jolie Brise*. She handed reaching foresail, set staysail and stood out to windward close-hauled on the port tack, We in *Ilex* substituted staysail for reaching foresail, and got down the jackyarder before it knew what we were about and could raise its usual objections to that operation. I must really raise my hat to our jackyarder and its unimpeachable behaviour in the race. Our jackyarder is a sail of truly feminine perverseness. In the normal way when most wanted up it jams: when most wanted down it fouls something and some luckless wight has to go aloft to clear the foul. During the race, knowing what to expect, the crew tried shock tactics. Manning the halliards sheet and downhaul stealthily and making noises about getting the jib in, we got that unsuspecting jackyarder down across the deck and stowed before it could manage one foul in protest. After getting in jackyarder we stowed mizzen, which is a hindrance rather than a help close-hauled in a sea, and attempted to follow in the wake of *Jolie Brise* whom we could still see between squalls. In this, unfortunately, we were not successful, the head-on sea stopping our weigh and sagging us off to leeward.

Down below, *Ilex* was getting into ocean racing trim. Unable to get her own back on the watch on deck who were driving her in this ruthless fashion, she wreaked an ample revenge on the watch below. In fury she hurled any loose articles off the racks on to the floor, and on to the occupants of the floor seeking sleep. Occasionally a playful wavelet rushing aft along the deck and lifting the hatch cover would drop a cupful or so of cold water on to the blankets of the sleepers. Lockers came adrift and dropped on to the occupant of the cabin floor aft. This individual became a species of tell-tale whose reproachful cries would inform the watch on deck when the bilge needed pumping. Withal the glass remained high and steady, the breeze never freshened to reefing point, and the long Atlantic rollers, which usually one expects underlying the boisterous short seas, never got up.

The fresh breeze had brought about a radical change in the situation. The big yachts, *Neptune* and *Jolie Brise*, forged steadily ahead and to windward, and we were powerless to prevent them. In turn, we were pulling right away from *Saladin* and *Maitenes*. The danger point had shifted from *Saladin* and *Maitenes*, to whom we had to give an inordinate amount of time (about seven hours), to *Jolie Brise*, who was giving us under an hour. *Neptune* we were not frightened of. She had to give us ten hours, and we were still reasonably close on her heels. All Friday we thrashed to windward. By Friday

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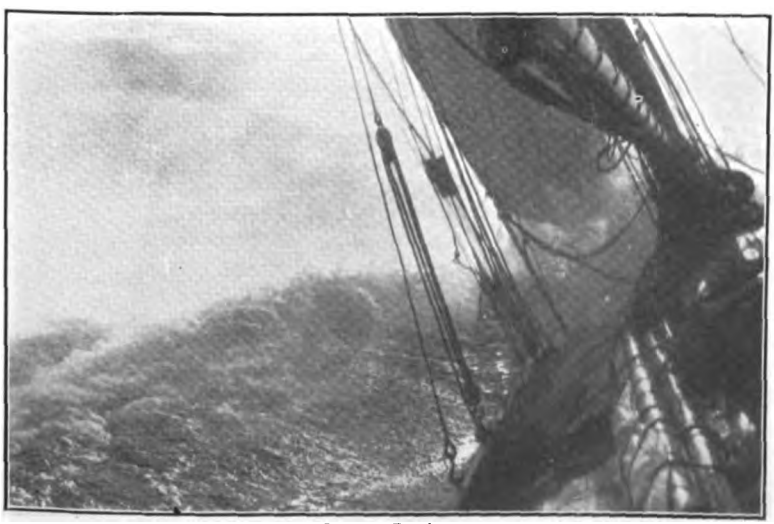
ILEX IN THE FASTNET RACE.

D. N. B. Hunt, Skipper



Ocean Racing.

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Fryer.

The Red Watch.

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night, the wind freshening, we had to ease the ship by lowering jib topsail and staysail in the early hours. At dawn on Saturday, we managed to get staysail and mizzen on her again, followed by jib topsail and jibheader as the wind eased about 8 a.m. We made our Irish landfall about 1 p.m., when we sighted the Old Head of Kinsale and went about at 2 p.m. on the starboard tack, running parallel with the Irish Coast and about six miles from it. Nearing Cape Clear the wind dropped light amid the united groans of the crew. Had the wind held we would have rounded the Fastnet not so very much outside our time astern of *Jolie Brise*. As it turned out, that last sixteen miles dead to windward in negligible airs gave *Jolie Brise* a clear nine hours lead—she rounded the Fastnet at 9 p.m. on Saturday, and we drifted round at 6 a.m. on Sunday morning. Rounding the Fastnet is always the event of the race, and can usually be guaranteed to provide the chronicler of the voyage with some comic relief. This race was no exception to the rule, and professional pride must not make me conceal the fact that our signals left something to be desired. As we approached the rock, our distinguishing flag hoisted, we fired a Verey light. A black dot appeared on the balcony of the lighthouse, placed himself where we could only see one of his arms and guess at the other and started to semaphore. All available brain on *Ilex* was turned on to reading, and good guesswork filled in the gaps in a string of letters and turned it into *Jolie Brise*. So far, so good, but all the crew of *Ilex* could not read the rest, and we gave it up. Undeterred, Black Dot continued to work himself up to a peak of signalling frenzy and eventually collapsed against the balcony rail, registering disapproval. Meanwhile one member of the crew was having a pleasurable morning. Hoot, having roped in a suitable assistant, had got out the signal flags and a book of the words and was looking like an advertisement for a flag day. Up went a vast string of flags to the crosstrees. No sooner were they up than up fluttered the answering pennant from the lighthouse. Black Dot had recovered. Things were looking up. The only beings who appeared at all disconcerted with the rapidity of the reply were our signalmen, who were now burrowing like moles into the book of words again. The ship drifted placidly towards the rock: "What kind of shock will we get as to our position from the lighthouse?" I wondered: "this flag business seems a slow process: however, our message must be nearly through by the length of the hoist." At this moment someone inquired what message we had hoisted. "I have just sent the general signal 'What,'" explained Hoot, still rushing anxiously through the pages of the code book.

There is no doubt that such a signal is a great temptation to a lighthouse keeper who has had nobody to talk to for the last two months. Black Dot reacted with energy and goodwill, but with complete lack of success. He might as well have burst into

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Gaelic. Perhaps he did. With the rock abeam we had gleaned nothing.

"But," began the Busy Bee, and that was as far as he got. A hoarse noise from the lighthouse silenced him and startled the gulls. It sounded like "Hullo!" It *was* hullo. We had established communication. As the one who talked most and did least I was deputed to shout back. Our conversation ran something as follows. (The reader must picture the yacht drifting past the light, minimum distance two hundred yards, gradually increasing.) "Hullo," from the lighthouse. "Hullo" (me). Pause—"hullo"—pause—"hullo"—pause—"*Jolie Brise* passed 9 p.m." (rest of sentence lost). "What?" (me)—"Hullo" (lighthouse)—"Hullo" (me): "You are next"—"When did *Neptune* pass?" (me, strain on larynx getting severe). "Try semaphore" (lighthouse)—"Can't read your semaphore" (me). "Wow" (tone of deep disgust from lighthouse). At this point my larynx threatened rupture and vocal communication was suspended *sine die*.

As we foregathered to discuss the news a voice was heard from our signal halliards. "Has he answered yet?" it said. There flaunted from the crosstrees a string of flags. Slightly flushed, our signalman was preparing another signal. "No, he has not answered" we said without enthusiasm. "What have you asked him with that little lot?" "They mean 'When,'" said our signalman proudly.

After rounding the rock we got a light breeze from the N.W. and set spinnaker to port. *Jolie Brise* had a clear nine hours lead. To drop that lead to under one was a bit of a problem. *Neptune* had evidently not rounded. Anyhow, why worry? We got all our soaked gear on deck in the pleasant sun, and with every stitch of canvas set prepared to enjoy what the sea had to offer us. Sitting aft on the counter we whiled away the time with the gramophone and revolver practice, and with idle guesses as to how the rest of the fleet were faring. At 8 a.m. our guesses began coming home to roost when we passed *Saladin* outward bound, followed an hour later by *Maitenes*. The latter looked rather the worse for wear, as if she had been well reefed down. It seemed fairly clear that *Jolie Brise* was, barring accidents, beyond catching, while *Saladin* and possibly *Maitenes* were still within their time of us.

We averaged about six knots to the Longships, with a maximum of seven and a half, a run all the way. As we neared the English coast the wind dropped lighter and lighter. Pendeen and Bishop's light were picked up at 3 a.m. on Monday and light breezes took us peacefully past the Runnelstone at 5 p.m. and into the middle of the fishing fleet from Penzance. It is surprising what an interest the fisher folk take in the race. One by one as they passed they waved or asked questions. "How are you getting on?"—"Are you leading?"—"You must have had it fresh by the Fastnet"—and so on.

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The same old light breezes took us to the Lizard and left us kedging at 11 p.m. on Monday night. It was painfully slow progress with the monotony relieved only by a flirtation with rocks off the Lizard by the watch on deck, who quite obviously thought that the watch below had had enough sleep. They started their watch with the gramophone until quelled with harsh words from below. This was followed up by much sail shifting and other indiscriminate noises "off." Then came the operation of kedging, followed by the breaking out of the kedge in an apparently flat calm. Scraps of conversation of which the following are samples drifted in the still air through the skylights—just enough to keep the watch below stirring in their bunks. "I think it's a seal"—"It isn't moving and there is a nasty swirl round it"—"Anyway we will know soon as we *must* hit it." "Seal be blowed. It's a rock, bear away. No can do, no steerage way." When the watch below took over at 2 a.m. the ship had drifted through, round, or over the seal and its *confrères* off the Lizard. By this time we were all experts at sail handling on moonless nights. On this Tuesday morning before dawn, we set spinnaker and reaching foresail and gybed twice before dawn. We had not seen *Saladin* or *Maitenes* since Sunday morning. In the meanwhile, on we drifted. I have an impression that we of the Red watch were not at our brightest at dawn on Tuesday. We would all have been the better for something fizzy out of a glass. The Mascot talked gloomily about running on the Manacles; the Busy Bee did not talk, but as he coiled up ropes he had the hiccups. The only note in my diary for Tuesday morning is a rude remark about the hiccups. I remember hoping that the hiccups would wake the watch below and that the watch below would brain the producer of the hiccups, when the smell of breakfast banished thoughts of hiccups, the Manacles, and our lost beauty sleep of the previous night.

If the wind remained light, it seemed fairly certain to save our time and get a second. If a breeze came up from the south or west, the situation was very open. Unfortunately, the wind freshened, and by noon we were racing along with a fresh following breeze, which must have reached our pursuers hours before. We had not much hope now of saving our time, though *Saladin* and *Maitenes* were not in sight. As we crossed the finishing line we learned that *Saladin* and *Maitenes* were 7½ hours behind us at the Start. Such a lead in time was, however, of not much value now the wind had freshened. So it proved. *Saladin* saved her time and we had to be content with third place. *C'est la guerre.*

In conclusion a few general impressions of the race. All on board were agreed that *Ilex* had never been better found and victualled than in this race. We had no trouble of any description with the gear. The wireless set, though not working properly, was persuaded to yield up the time signals and weather forecasts without trouble,

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when required, and when adjusted will be a great asset to the ship. Hunt combined the duties of skipper and navigator, and very excellently he did both. Our landfalls were beyond reproach. Francis, who distinguished himself last year as ship's carpenter when he spliced the broken topmast during the race, was indefatigable again this year on all kinds of odd jobs, usually performed in his watch below, ranging from the manufacture of bamboo gramophone needles and the stripping (and correct re-assembly!) of the ship's stopwatch to winding frame aerials. The yacht hand excelled himself in the culinary line. After his fifth ocean race he must have few rivals as a cook in a sea.

We were a little unfortunate, firstly, in being almost becalmed with a dead beat before us sixteen miles off the Fastnet, and secondly in the freshening of the wind at the most inopportune moment as we neared Plymouth.

It is becoming increasingly clear that *Ilex* is very ill-served by the special O.R.C. handicap formula. This year, although the smallest yacht in the fleet, we gave half the fleet time. *Jolie Brise*, a big powerful yacht twice our size, gave us 40 minutes. To *Saladin*, almost as large, we gave over five hours. Luck and hard sailing alone can give us another winning flag. We will not get any assistance from the formula.

The starters were as follows :—

Yacht.	*Rig.*	*Tons.*	*Handicap.*	*Owner.*
Guerveur ...	Yawl	48	Scr. ...	Baron A. de Neufville.
Maitenes II ...	Ber cutter	25	15 hr. 22 min. 30 sec.	Lt. L. B. Luard.
Ilex	Yawl	20	10 hr. 35 min. 40 sec.	R.E.Y.C.
Jolie Brise ...	Cutter	44	9 hr. 54 min. 30 sec.	Mr. R. Somerset.
Neptune ...	Cutter	46	30 min. 45 sec. ...	Lt.-Col. G. L. Chambers.
Vega	Ber schooner	—	13 hr. 9 min. 15 sec.	M. Balderweek
Amaryllis ...	Yawl	37	3 hr. 45 min. 30 sec.	R.N.C., Dartmouth.
Grey Fox ...	Ketch	33	5 hr. 38 min. 15 sec.	Mr. N. Newgass.
Saladin ...	Cutter	34	17 hr. 15 min. 15 sec.	Mr. Jugo Simon.
Cariad ...	Cutter	34	16 hr. 54 min. 45 sec.	R.N.E.C., Devonport.

Order of finish on corrected times :—*Jolie Brise, Saladin, Ilex, Maitenes II.*

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MEMOIR.

MAJOR-GENERAL ARTHUR EDMUND SANDBACH, C.B., D.S.O.

THE subject of this Memoir, Arthur Edmund Sandbach, was born on July 30th, 1859, at Hafodunos, in Denbighshire. He was the third son of Henry Robertson Sandbach, D.L., J.P., of Hafodunos. His mother was daughter of Captain Martin Williams, of Bryn Gwyn, Montgomeryshire, and to her sister, Miss Katherine Williams, this family property descended; subsequently Miss Williams made the place over to her nephew, Major Martin Sandbach, R.A., and, on his death in 1895, his younger brother, Arthur Sandbach, became the owner of Bryn Gwyn.

He followed his two elder brothers to Eton (Durnford's House) when he was twelve years old, was placed in the IV Form, and, as the youngest of three contemporary brothers, was termed Minimus, a title which stuck to him all his life with his old schoolfellows. Among his contemporaries at Eton in the Corps we find Hawker, Hussey, Anstruther and Mills; in the rest of the Army, Sir William Pulteney and many others. Amongst statesmen and diplomatists, Lord Curzon and Sir Arthur Lawley, whilst the Church and Literature are adequately represented by the present Dean of St. Paul's.

He was six years at Eton, and passed direct from the VI Form into Woolwich in 1877, when he was fifteenth on the list. He was a "wet bob" at school, and also an ardent member of the school Volunteer Corps, in which he became a serjeant. We may be sure that even then he was a very efficient drill; legend has it that he was rudely rebuffed at Woolwich by his Division Officer when he pleaded his status in the School Corps as a ground for being excused some of the preliminary drills which "last joined" underwent. From the first he was unusually smart as a cadet, and as a result was specially made an Under Officer out of his turn, with the general approval of his fellow cadets. One of his Woolwich contemporaries, and subsequently a comrade in the Soudan, now General Sir Reginald Wingate tells the writer that Sandbach went by the name at Woolwich of "the lordly stag," which is curious in view of the fact that twenty years later, when serving with the Egyptian Army, where everyone had a nickname, Sandbach was christened "the stately stag," which was held to describe very well his carriage and his walk. The nick-

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name in his own batch and obvious to the Corps was "Sandbags," which was perhaps the most lasting of his different sobriquets.

He was gazetted to the Corps on 6th April, 1879, being the eleventh out of a batch of twelve, of which John Winn was the head and S. G. Burrard second. At Chatham, he took up rowing again, and induced the batch to follow his example. He was stroke and best oarsman in the batch Four. He taught the others how to row, and his crew were head of the river whilst the batch was at the S.M.E.

He was also chief whip of the Beagles whilst at Chatham, kept a horse, and hunted. One of his batch, referring to Sandbach at this period, writes: "He was a true gentleman, he never did or said a mean thing, never said a word against anyone or to hurt anyone's feelings. He was a very upright and straight-living young fellow, he had high ambitions and was a hard worker; among his own batch he was decidedly popular, and never made an enemy."

Sandbach must have given satisfaction to the authorities as a young officer, because at the conclusion of his S.M.E. Course he was at once appointed to "A" Troop (Pontoons), and then made his first acquaintance with Aldershot, where so much of his subsequent Home Service was spent. Colonel Fitzroy Somerset was C.R.E., with Sir Howard Elphinstone as O.C. Troops and Companies. Major Robert Bond commanded "A" Troop, with Godsal, Pemberton and Irvine as the other three subalterns. The "C" or Telegraph Troop was commanded by Major Hamilton, one of whose subalterns, Sir Ralph Anstruther, was an Eton friend of Sandbach's, and writes of him at this period: "I can recall him to-day as he was then, a tall slim lad with very fair curly hair, intensely keen on his duties, with a happy ingratiating manner and a pleasant smile for all and sundry."

Colonel Pemberton, a fellow subaltern in "A" Troop, tells of Sandbach's efficiency as an officer, his attention to duty, and the good work which he did on active service in Egypt; "with an easy assurance, pleasant manners and *joie de vivre*, he was an attractive personality, we were always the best of friends and I admired his forceful character and his ambition to push himself to the front."

In 1882, Sandbach had his first experience of active service in the Egyptian Campaign, when "A" Troop, "C" Troop and the Field Park all went to Egypt together and back in the same ship, the *Oxenholme*.

The Pontoon Troop did useful service in the Sweetwater Canal, and was in close support at Tel-el-Kebir, but in view of the course which the campaign followed, and of its early conclusion, the Troop had no opportunity of any very important action.

Sandbach remained in "A" Troop for three years, and enjoyed his service with it, and life at Aldershot immensely. The Troop in those days used always to send a bridging detachment to the Royal Military Tournament at Islington, and Sandbach was in charge of it

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Major-General Arthur Edmund Sandbach, C.B., D.S.O.

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Egyptian Army, 1897–1898.

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on at least one occasion, when he rode his chestnut trooper "Ascot" in the tent-pegging competition, and was third in the whole Army. Then in the winters he used to hunt with the Garth, the H.H., and sometimes with "The Vine."

He was a very attractive fellow in those days; the writer remembers so well the impression made on General Fred. Willis, then commanding a Brigade at Aldershot, and for some time a dining member in the R.E. Mess: he thought Arthur Sandbach the ideal of what a young officer and gentleman should be, and tried ever so hard to secure him for his A.D.C.

In the summer of 1884, after three years' service in "A" Troop, Sandbach came up for foreign service, and on September 3rd embarked to join the 11th Field Company, which had just arrived at Cairo and was expecting to go up the Nile as part of the expedition in relief of General Gordon. Only a section of the Company, however, ascended the river, and Sandbach, the junior subaltern, had to stay in Lower Egypt; later on, however, his opportunity came, and he grasped it. After the fall of Khartoum it was settled to send a force to Suakim, and as part of the preparations Colonel Hutton organized and trained a Mounted Infantry Battalion at Cairo of which Colonel H. F. Grant, 6th D.G., was ultimately to have command. Sandbach describes as follows what happened:—

"I had known Col. Hutton when he was a Brigade Major at Aldershot; so one day I asked him why he did not have an R.E. Section with his M.I. battalion. He took the idea to the General in Cairo and got his sanction, and then asked Col. Maitland (the C.R.E.) to nominate me, and very soon I found myself at Abbassiyeh with an R.E. Section of 28 all told, drawing saddles, mounted equipment and Arab horses. The Section was selected from the 11th Field Co., which was still quartered in Cairo. A telegram was sent to the War Office asking for my replacement by another officer, as I was proceeding to Suakim with Mounted Infantry. A reply came 'Stop Sandbach—no R.E. officers can be spared for Mounted Infantry.' My Section was duly ordered back from Abbassiyeh to Kasr-el-nil, the breeches and puttees of the men were returned to store, and there was some friendly chaff in the Company about the cavalry soldiers of the R.E. who thought they were off to Suakim. I was naturally bitterly disappointed after all that Col. Hutton had done to get my Section organized. I sat down in the Orderly Room at Kasr-el-nil on our return there and wrote off two letters to London, worded in much the same way, one to Sir John Stokes, D.A.G.R.E., and another to Sir Andrew Clarke, Inspector-General of Fortifications. I explained the circumstances and what had been intended to be our work with R.E. tools and explosives, of cavalry pioneer equipment carried on our saddles, and told both these R.E. Generals that I felt sure that the nature of the organization of the R.E. Mounted Section

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and its proposed duties had not been understood in the War Office. To my intense joy in five days time a telegram arrived from the War Office saying: 'Sandbach and Mounted R.E. Section approved.' I had replies by letter from each of the Generals; Sir Andrew Clarke merely said he was sorry for my disappointment; he, too, had had his disappointment about active service, and so on. Sir John Stokes replied that he showed my letter to the Duke, and that, as soon as H.R.H. understood the details of the proposal, he gave his approval at once, and a telegram to that effect had been sent to Cairo. Accordingly we went back to Abbassiyeh, had some more riding instruction with the men with Colonel Hutton, embarked at Suez to join the M.I., and reached Suakim early in April, a few days after the fight at McNeil's Zareba. I reported to Col. Grant, my new C.O., and my R.E. Section was posted to a Company of Coldstream Guards M.I., commanded by Captain John Ross, of Bladensburg, whom afterwards we knew so well in Dublin."

Sandbach goes on to describe some of the work which his detachment did whilst at Suakim; the story has been told at length because it was from this beginning that later sprung first of all the R.E. Mounted Detachment, and then the Field Troop R.E.; the incident illustrates Sandbach's persistence in a good cause, whilst it shows that Sir John Stokes and H.R.H. were not so conservative as they have been sometimes painted, though, on the other hand, Sir Andrew Clarke on this occasion belied his usual reputation of a reformer.

In Colonel Grant's M.I. Battalion was serving the future General Sir Horace Smith-Dorrien, who, in reference to these days, writes: "At Suakim, 1885, Sandbach and I served in a battalion of Mounted Infantry together, and a very remarkable battalion it was, for it was made up of sections from many units of the British Army, even Marines, proving that horse-marines are a possibility. Sandbach commanded the R.E. Section, and was popular with all, as he was always cheerful and ready to help anyone. The Corps was about 800 strong, and had on its rolls representatives of 35 units."

In May, 1885, owing to complications with Russia, the Suakim Expedition was stopped, and most of the troops were withdrawn, Sandbach with his detachment rejoining the Headquarters of the 11th Field Co., R.E. At Suakim he had made the acquaintance of Col. E. P. Leach, V.C., R.E., then commanding the 24th Company, R.E., and from him he received advice to go to India for his foreign service. Colonel Bindon Blood, whose acquaintance Sandbach also made about the same time, gave the same advice, and asked him to join the Bengal Sappers and Miners, to the command of which Blood was about to succeed.

Sandbach accordingly volunteered for service in India, was ordered home and given leave before embarkation. However, shortly after his arrival home, in July, 1885, he was laid up with malarial fever,

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and had to take sick leave for the winter of 1885–6. In the following spring he was posted to the 12th Field Co. at Chatham, pending embarkation for India in the autumn. This Company was commanded by Major J. C. Tyler, then the exponent and pioneer in Field Company development, and the inventor of the tool cart which bears his name.

One of the subalterns of the Company, now Major-General Sir Hugh Bruce-Williams, writes of Sandbach's sympathy to the young officers at Chatham, and how constantly he was on the look-out for keen youngsters who would be likely to do well in the troops and companies of the Corps. "It was he certainly who put the idea of going into a Field Company into my head, and it is thanks to his advice that I eventually went to the Staff College."

In September, 1886, Sandbach sailed in the Indian troopship *Jumna* for Bombay, *en route* for the Bengal Sappers and Miners at Roorkee. In some interesting notes regarding his earlier experiences he tells us that Colonel Blood and the Adjutant (W. A. Cairnes) met him at Roorkee Station and informed him he was to go on at once to Upper Burma, and join there the 5th Company of the Bengal Sappers and Miners, then commanded by Captain M. C. Barton, whom 19 years later Sandbach was to succeed in command of the Sappers at Roorkee. In regard to his Burma experiences, Sandbach was at first handicapped by his complete ignorance of Hindustani and of Indian methods. The country itself was very unsettled, and bands of decoits still infested Upper Burma and entrenched themselves in stockaded villages, which small flying columns had to attack and capture. There was plenty of work and much experience to be gained by young officers, together with the spice of danger, and, on one occasion, Sandbach, if not wounded, at any rate had the experience of having his horse shot under him. After five months of this hard campaigning in a feverish area, Sandbach was ordered back to Roorkee, whence he made a short visit to Simla to shake off a fever attack. He tells us in his notes of the then Viceroy, Lord Dufferin, and his Military Secretary, Lord William Beresford, and how he saw for the first time "the paraphernalia of the Viceregal Court in India, in which I was destined later to take a personal part."

The next two years Sandbach spent at Roorkee; he managed, however, to make two visits to Cashmere, and on the second occasion had a four months' trip, going from Srinagar to Leh, and thence to Haulé, in Thibet, whence, after crossing passes over 17,000 feet, he reached Simla from the north; for three months after leaving Leh he had not seen a white man, and had only spoken in Hindustani to his servant.

He had now the good fortune to drop in for the Sikkim Expedition of 1888–9; the fighting was soon over, but a fortified position was

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held all through the winter of 1888–9 by the troops of the column, and the Sappers had plenty of work in road-making and hutting. In the summer of 1889 the fever from which Sandbach had suffered at intervals became worse, and in August he was sent home on a year's sick leave, having become a Captain on the 15th of April previously. On the ship going home was General W. K. Elles, then Adjutant-General in India, and the two made friends over some problems and conundrums which the General gave Sandbach to work out; thus it came about that later on Sandbach became the General's A.D.C. in India on the completion of his sick leave. Sandbach was two years A.D.C. to Sir William Elles at Rawalpindi; during this period Sir William was given command of the Hazara or Black Mountain Expedition, which lasted from March to June, 1891; Sandbach acted as principal A.D.C., with Lieut. Wilberforce (now Sir Herbert Wilberforce) and the late Prince Christian Victor to assist. In his final dispatch published in the *London Gazette* in October, 1891, Sir William referred to Sandbach as "having already seen considerable and varied service in the Field, and as having been specially useful."

On completion of two years as A.D.C., Sandbach rejoined the Bengal Sappers and Miners in January, 1892, when he was sent on special duty to Gilgit, where he took the place of Captain Aylmer; Aylmer had gone to Gilgit directly after the Black Mountain Expedition, and in the interval had helped to make history and to earn for himself a V.C. in the romantic fighting at Nilt and Hunza Nagar, so well described in Knight's *Where Three Empires Meet.*

To be chosen to succeed Aylmer at this most important frontier post was a compliment, and reports all say how well Sandbach did during his seven months at Gilgit.

At Gilgit, Sandbach was a Special Service Officer on the British Agency, and had only a small detachment of Bengal Sappers with him. His duties generally were to improve the communications throughout the district and act as adviser to the British Agent on all engineering matters. As Sir Fenton Aylmer writes: "To look after R.E. matters in the Gilgit district was a heavy business, and entailed endless riding of long distances over vile roads. Most things had to be done with local labour (coolies) totally untrained, and it was always a case of making bricks without straw."

One incident of these times deserves recording.

It happened that Sandbach, smartly costumed and well retinued, was riding out one day from Gilgit along a bridle path which led towards the frontier. There appeared coming to meet him along the path a tattered looking individual, perhaps a pedlar, his clothing in rags, astride a pony, with a native of Central Asia following in rear.

The path was narrow, and the ragged one endeavoured to clear the way for *Huzoor;* in the effort, the roped stirrups slipped, and after a momentary struggle the rider bit the dust. The kindly Captain halted and scanned the fallen one as he rose. Surely no pedlar this,

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the face despite the dirt seemed to grow familiar. "No, it can't be; but yes, yes, it is, Pembo."* Last met when a fellow subaltern in "A" Troop, and now on his way back to civilization from one of his adventurous explorations of Central Asia.

A curious meeting that, and one over which they both often laughed in years to come.

His service at Gilgit ended Sandbach's Indian tour, and he came home in the summer of 1893 and joined the Depot at Aldershot on the 6th August.

It was fitting that Sandbach's first home appointment should be to the command of the Mounted Detachment of which he had been the first exponent in 1885. A Mounted Detachment had been in existence as part of the R.E. Field Depot since 1888, but so far had not been formerly recognized in Army Establishments; it had been commanded since its formation by Captain Kincaid, who vacated it in August, 1893, on being appointed to the Egyptian Army.

In the spring after Sandbach assumed command, the Mounted Detachment became a separate unit under Sandbach, with H. A. Micklem as his subaltern. The new unit attended the Cavalry Manœuvres of 1894 at Churn, and its Commander received high commendation from the Inspector-General of Cavalry, Major-Gen. Keith Fraser.

Sandbach commenced to work for the Staff College directly he joined at Aldershot, and most of his off duty hours were spent in study at the upright desk at which he always worked; he went up for the examination in 1894, and although he failed to qualify he did sufficiently well to be placed on the list of Special Officers for nomination kept by H.R.H. the Commander-in-Chief.

In April, 1895, Sir Arthur Mackworth, who had been O.C. T. and C., succeeded Colonel Bruce Brine as C.R.E., whilst Lieut.-Col. A. Dorward became O.C. T. and C. The Adjutancy became vacant at the same time, and was offered to and accepted by Sandbach, who took up his new duties on the 25th April, 1895. He was not destined, however, to hold this coveted post for long, for in the autumn of the same year he was one of the Commander-in-Chief's nominations to join the Staff College Course of 1896, and he accordingly vacated the Adjutancy and joined at Camberley on 15th January, 1896.

He found himself one of a course which, judged by subsequent events, was a very remarkable one. Among the nine nominations was the future Earl Haig.

Captain E. H. Allenby, 6th D.G., the future Field-Marshal, was Master of the Drag; Sir George Macdonogh and Sir James Edmonds represented the Corps; we find in the list—in addition to General Sir Richard Haking and Lt.-General Sir William Furze—the names of eight future Major-Generals, including the brilliant "Tommy" Capper, and, with one of them, Sir George Forestier Walker, Sandbach was to be subsequently associated in Ireland and in France.

* Colonel E. St. C. Pemberton.

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In this brilliant galaxy Sandbach held his own, and he got an excellent leaving report from Sir Henry Hildyard, a Commandant by no means easy to please.

His services were already in request, and within a fortnight of the conclusion of the Course, Sandbach embarked for service with the Egyptian Army on the last day of 1897.

He arrived in Egypt at a very opportune moment, a few months before the Battle of the Atbara, and the subsequent advance on Omdurman.

He was employed during the eleven months he was with the Egyptian Army on Staff and L. of C. work; he was successively A.A.G., Dongola District, Commandant Wadi Halfa, and A.A.G. L. of C. He finally came to the front as A.A.G., Headquarter Staff, in time to be present at the last battle, that of Omdurman. He gave great satisfaction as evidenced by reports sent home about him, by his mention in dispatches, and by the award of a Brevet Lieut.-Colonelcy.

Sandbach's period of service with the Egyptian Army came to an end on the 30th November, 1898, but he was home in time to attend the banquet given at the Mansion House on November 4th to Lord Kitchener and to those of his officers who were within reach of London, and it was shortly before that date that his next form of employment was settled, viz., Military Secretary to the Viceroy of India, Lord Curzon. The future Viceroy apparently sounded his old schoolfellow on the subject when they met at the Eton dinner given to Lord Curzon on October 28th, but the appointment was actually suggested by Sir Walter Lawrence (Private Secretary to Lord Curzon), after the advice of both Lord Roberts and Lord Kitchener had been taken. Sandbach had already accepted the post of Military Secretary to Sir George Luck, then commanding one of the larger areas in India, but Sir George waived his claim when he heard of the future Viceroy's wishes.

Sandbach went to India at the same time as Lord Curzon, and took over his duties on arrival. The association between the Viceroy and his Military Secretary was not a happy one, and did not last long. Temperamentally they were unsuited to one another, and it was probably a relief to both when the outbreak of the South African War gave Sandbach the opportunity of proceeding to the scene of operations as a Special Service Officer on the Indian Establishment.

It is well to record that there was nothing in Sandbach's action at the time which could give his friends and well-wishers cause for regret. Among these friends Sir Walter Lawrence, who had formed a high opinion of his work in Gilgit, and had stayed with him at the Staff College, does regret that by his suggestion Sandbach should have joined an appointment where there was no scope for military ability. But when he and Sandbach reached India, it was soon evident that the latter's duties were those of a *major domo*, and that

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neither the Viceroy nor the Military authorities had any use for his experience and professional knowledge. He was not fitted by inclination for domestic affairs, and estrangement from all but the ceremonial side of military life vexed him. When the war broke out in South Africa, Sir Walter suggested to Sandbach that there was a way out, and he took it.

He embarked for South Africa on November 7th, 1899, and on the 28th December was appointed A.A.G. Intelligence to the Natal Army. He held this position until the Natal Army was broken up in October, 1900, when Sir Redvers Buller, shortly to be followed by Sandbach, returned to England.

It so happens that the writer is in a position to speak with some knowledge as regards Sandbach's work in South Africa, because after being in Ladysmith he joined the staff of Sir Redvers as soon as the relief was effected; he found them full of the excellent work which Irvine and the Pontoons and Jelf with the Telegraphs, had done throughout the long and trying relief operations, whilst Sandbach and the Intelligence, and Rawson with his cloud signalling, had also made a great impression. The Engineers had indeed done their bit towards the relief of Ladysmith.

It is to be realized that at this period the Intelligence Division of the Staff was much more " on its own " than in later years; the Chief Intelligence Officer dealt direct with the G.O.C., and not through the intervention of the " A " Staff, which was the General Staff of those days. In this way Sandbach was in very close touch with Sir Redvers Buller, reported to him daily, and was much in his confidence, and Sir Redvers had the highest opinion of him. In the final stages of the relief operations, after the capture of Hlangwane and the subsequent failure to make ground to the west of it, it was largely Sandbach who persuaded Sir Redvers to change his plans and to attack the centre and left of the Boer position on Pieters Hill; Sandbach had found for this purpose a suitable crossing over the Tugela river where it was possible for Irvine and his Pontoons to construct a bridge protected from hostile fire. The plan was adopted with success, and the way into Ladysmith was found at last; Sandbach's share in the credit was admitted by all from Sir Redvers downwards, and the facts are brought out in the official as well as in *The Times* History of the South African War. He had been active in all the trying operations subsequent to the battle of Colenso; in *The Times* History we read of his having been on Spion Kop on the day of the fighting there, a very unpleasant place at the time, and having brought down a message from General Thornycroft to Sir Charles Warren.

When the writer joined the Natal Staff he well remembers Sandbach and his scallywag and picturesque following of white men, kaffirs and Cape boys, the wagons, Cape carts and quaint vehicles which carried their belongings, the strings of horses, donkeys and cattle. What

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a show they made on the march, with Sandbach, irreproachably costumed, at their head, and how difficult sometimes they were to control. It was a large organization, and to help him there served under Sandbach, although senior to him in army rank, Colonel Seymour Munro, a great character, boisterous and delightful, and who always addressed and spoke of his Intelligence Chief as "the Czar."

We all liked Sandbach, and he did excellent work in the post-Ladysmith operations of the Natal Army. He was with the advance by Laing's Nek, the fighting at Alleman's Nek, the engagement at Bergendal, and the subsequent movement to Lydenberg and Pilgrim's Rest.

He was mentioned three times in dispatches by Sir Redvers: "Has been untiring and has been of the greatest assistance to me." "The Intelligence Department has been under Lt.-Colonel Sandbach; this officer possesses energy, enterprise and system, and has devoted himself to the work. The Department has been highly successful."

The Natal Army came to an end when Sir Redvers was ordered home on 6th October, 1900; Sandbach was then sent to Pretoria for Intelligence work, and stayed there about a month, after which he was ordered home *en route* for India, landing in England on 8th December, 1900.

For his services in South Africa, he was awarded the D.S.O., and the Queen's Medal with six clasps.

After a couple of months' leave, Sandbach was employed for a few weeks in assisting his neighbour, Sir Watkin Wynn, at Wynnstay, in enlisting and training the 88th and 89th Montgomeryshire companies of the Imperial Yeomanry. He then passed on to the Mobilization Branch at the War Office, and was employed for nearly 18 months under Sir Percy Lake in revising the schemes connected with the defence of England.

It was during this period, on January 15th, 1902, that Sandbach married at St. Paul's, Knightsbridge, the Hon. Ina Douglas-Pennant, daughter of the second Baron Penrhyn.

On the 26th Sept., 1902, Sandbach, then a regimental Major and about two and a half years off attaining his regimental Lieut.-Colonelcy, embarked for India to complete the tour which he may be said to have commenced when he went to Lord Curzon as Military Secretary. His first appointment was C.R.E., Narbudda District, Jubbulpore, from Sept., 1902, to April, 1904. The only information the writer has gleaned about this period is from a brother officer then at Roorkee, who writes, "we used to hear characteristic stories of his ordering the Jubbulpore garrison out for some tactical exercises when he happened to be for some brief period in temporary command of the Station." It would appear, however, from official documents, that at one time during this period Sandbach acted as Commander of the Jubbulpore Brigade for five months.

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In February, 1904, he became a Brevet-Colonel, and in May of the same year, with still a year to run, before becoming a Regimental Lieut.-Colonel, he was appointed to succeed Colonel M. C. Barton in command of the 1st Sappers and Miners, Roorkee.

For the benefit of readers who, like the writer, have never been to India, it is as well to give some idea of the command to which Sandbach had been appointed. It included about 22 British officers, 30 British N.C.O.s, and about 1,400 Indian ranks. It comprised six Field Companies, Balloon Section, Pontoon Section, Printing and Photograph Section, and later, due to Sandbach's incessant bombardment of Simla, a Mounted Detachment was added, to be followed afterwards by a Field Wireless Section. There were usually two of the Field Companies on detachment, one at Peshawar and one at Rawal Pindi. One who served under him, and to whom the writer is much indebted, states as follows :—

" He took over what we were pleased to think was a good show, and he most certainly improved it. He was a very live wire, especially in an administrative way ; he was closely in touch with A.H.Q. at Simla ; he knew all that was going on, and he kept the 1st S. and M. and their capabilities and possibilities well to the fore among the powers-that-be at A.H.Q. He was a great exponent of the science and art of military co-operation, and he was well ahead of his time in that essential outlook. He boomed the Corps in the eyes of the Army at large, he always strove to make the 1st Sappers and Miners the most soldierly of all soldiers ; any idea of an R.E. officer being anywhere except in the forefront of the battle was anathema to him ; the Corps could nowhere have found a more able and accomplished champion. He was, of course, constant in his help and encouragement to his officers to go to the Staff College and take up service on the Staff ; he instituted and obtained sanction for a system whereby the Commandant visited and inspected his outlying companies on detachment."

" In the great Rawalpindi manœuvres in December, 1905, under Lord Kitchener, with the present King (then Prince of Wales) as spectator, Sandbach saw to it that practically every possible field engineering activity was represented in the opposing forces by units from the 1st S. and M.

" He made, as a general training policy, continuous attempts that Sappers should, whenever and wherever possible, have some infantry with whom to work in co-operation in field training.

" His military qualities and his previous service made him a personality deeply respected by all his British officers and N.C.O.s, whilst his handsome appearance and irreproachable turnout made him highly admired by his Indian soldiers.

" His friendly and amiable characteristics endeared him to all ranks ; he was interested in all forms of sport, and much enjoyed the polo and shooting, for which Roorkee affords such good facilities."

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Speaking of his nickname *Huzoor*, the same writer adds: "The term *Huzoor* (Your Honour) was used of him by his British officers when speaking of him amongst ourselves; it always seemed in a genial chaffing spirit to hit off his air of distinction."

The above is only one of a number of tributes as to Sandbach's work at Roorkee, which had been received from officers who served under him in the Sappers and Miners. A remarkably large proportion of them have since risen to high distinction, and are ready to admit how much they learnt from Sandbach and how much they owed to his inspiration and example.

An R.E. officer who held a high position in India at the time, writes of Sandbach as follows:—

"I know he was a great success as Commandant of the Bengal Sappers and Miners, and did a lot for that Corps, and his juniors always spoke highly of him. He had the courage of his opinion, and backed up the Corps bravely. Whilst Commandant he held and organized the centenary of the Bengal Sappers and Miners, a great success, to which Lord Kitchener went, enjoyed himself, and was generally very pleased."

His tenure of command was marked by the erection of the war memorial which commemorates the 50th anniversary of the blowing in of the Kashmir Gate at Delhi during the Mutiny of 1857. This memorial took the form of the Ghuznee tower, which was designed and built by the Bengal Sappers and Miners, and forms to-day the nucleus of the larger war memorial which has been built to commemorate the memory of those who fell in the Great War.

It was during Sandbach's time at Roorkee that the Corps was honoured by receiving the designation of Prince of Wales' Own (subsequently changed to King George's Own) Sappers and Miners.

In October, 1907, Sandbach relinquished command after holding it for three and one-third years, and, as one who served with him says, "he left the Corps in a very high state of efficiency, and to the great regret of all ranks, British and Indian, for whose good he was ever solicitous."

Probably no period in Sandbach's service was so successful and so instrumental for good as this, his last tour in India.

The Indian authorities recognized his good work, and in a most appreciative letter the G.O.C. Eastern Command informed the War Office of Sandbach's performances, whilst in January, 1907, he was recommended by the Commander-in-Chief for promotion to the rank of Major-General. On arrival home Sandbach, with still two and one-third years more to run as Regimental Lieut.-Colonel, was given the post of C.R.E., North Aldershot, on Dec. 2nd, 1907, and held this for eight months, at the end of which, on August 1st, 1908, he succeeded Irvine in the post of O.C. Troops and Companies.

General Sir Horace Smith-Dorrien commanded at Aldershot during the whole of Sandbach's stay there, and the Chief Engineers were,

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first, Colonel P. T. Buston, and after him Colonel George Scott-Moncrieff.

Sandbach's time as Lieut.-Colonel came to an end on the 9th April, 1910, when he was placed on half-pay, nothing of great importance having occurred during the twenty months he commanded the Troops and Companies.

After six months on half-pay, on the 7th October, 1910, he took up the post of Chief Engineer in Ireland, which he held for close on four years, in fact, until the commencement of the Great War. General Sir Neville Lyttelton was in command at the commencement, and was succeeded later by General Sir Arthur Paget. Sandbach served under three M.G. i/c A., Generals Bunbury, Hadfield and Friend.

Whilst in the Irish Command, Sandbach lived at Ashtown Lodge, Castleknock, and in his responsible post he found full occupation.

It was at this time, however, that a great disappointment befell him; he had been a Brevet Colonel since February, 1904, and in July, 1911, reached the top of the Colonels' List; however, on the 24th of that month he was passed over for promotion, and between that date and the outbreak of war, thirty-five in all were promoted over his head. The cause of this supercession is not clear, but it did not lie with his immediate superiors in Ireland, who consistently recommended him for promotion. Sandbach, of course, felt this very keenly, but those who knew him at the time are aware of the fine spirit with which he met his chagrin and did his best at the work which lay at hand.

When the War broke out, Sandbach was given the post of Chief Engineer, Second Corps, under Lt.-General Sir James Grierson.

Shortly after the landing of the H.Q. of the 2nd Corps in France, the B.-G.G.S. of the Corps found on visiting Havre (No. 1 Base) that the Commandant had collapsed, and refused either to give orders or to sanction them being given by a subordinate. With the prospect of the immediate advent of troops something had to be done, so Sir James Grierson on the 16th August detailed Sandbach to be temporary Commandant of No. 1 Base, and reported the fact to the I.G.C.

Regarding this phase of Sandbach's war work, Major-General Sir F. S. Robb, who was I.G.C., writes as follows:—

"Important though the charge of this main Base was which had thus temporarily devolved on Sandbach, nobody could at that time have anticipated the far more important role which he was destined to play.

"The overwhelming pressure of the Germans forced the British Army back in a direction far eastward of the original L. of C., which had thus become open to an attack from the direction of Amiens, already in the enemy's possession. It was therefore decided, on the 29th August, to change the main base from the mouth of the Seine to that of the Loire.

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"In view of the fact that the original L. of C. were practically without defensive troops, and that an attack on them was momentarily expected, the situation at Havre, where some 60,000 to 70,000 tons of warlike stores had already been unloaded, was one of extreme danger. Sandbach grasped the situation at once, and threw his whole energy into saving the stores and shipping, and he was further impressed with the gravity of affairs when Lord Kitchener, after visiting Sir John French at the Front, returned through Havre, giving him the latest information and emphasizing the paramount importance of sacrificing everything to speed.

"By 9.0 a.m. on the 5th September, the place was clear of stores, viz., in less than seven days of the receipt of the order to re-embark them, so that the clearance had been effected at the rate of from 9,000 to 10,000 tons a day. In order to appreciate what this means, it may be recorded that, even after the home ports had been expanded to meet the requirements of the world war, the average daily shipment from Southampton was 2,000 tons, from Richborough 3,000 tons, from Liverpool and Newhaven 3,700 tons each."

In the *Official History of the War* it is recorded that in four of the seven days in question 20,000 officers and men, 7,000 horses and 60,000 tons of stores were shipped from Havre to St. Nazaire.

Sandbach remained at Havre until 7th September, when he returned to his Corps, then on the Marne, just as the battle of that name was developing.

The following are some glimpses of Sandbach's work as Chief Engineer, Second Corps:

Sir Horace Smith-Dorrien in testifying to Sandbach's work, writes: "I found him a loyal and competent Chief Engineer. He always played the game and did his work well without ever being flurried; in fact he was always cool, calm and cheerful, and therefore an excellent comrade in trying circumstances. He joined me first in the neighbourhood of the Petit Morin River, just south of the Marne, as the battle of that name was developing."

Major-General Sir George Forestier Walker, who was B.-G.G.S. Second Corps at that time, pays him a warm tribute.

"His work during those strenuous early months of the War was always first-class, and no commander could have been better served in R.E. matters than was his Chief, whilst no Chief of the Staff could possibly have had a more devoted, considerate and able colleague—quick, cheerful and resourceful, his work on the rear and alternative positions which we had to construct in the early days in Flanders was very good, and he was a great asset to me and to the General Staff generally. Incidentally, he was the originator of the word 'switch' to indicate that type of alternative line of defence which ran into the original line at an oblique angle, and thereby had certain advantages. I remember so well his proposing it when we were struggling for a descriptive word."

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Colonel D. M. Griffith, always a great admirer of Sandbach, writes: "I saw him at his best one day during the War—he was acting C.E. of the Second Army, and on March 15th, 1915, came up to see us in the 28th Division billeted in Ypres. He insisted on going round the front line with me, and I took him all round by Ypres, Commines, north of St. Eloi, and even up to the bluff opposite Hollebeke Château and back by Zillebeke Woods, a nasty, unhealthy spot. He did not seem to mind going anywhere, and it was only with some difficulty I got him to discard his red cap, or rather to cover it with a khaki handkerchief. We had few communication trenches in those days, and it meant dodging from cover to cover going up to the front in daylight.

"He was most helpful in getting us R.E. stores, plant, etc., and sent his S.O. by car down to Paris to get us electric torches and lamps to help our work in the mines. He was a splendid Chief Engineer."

In recognition of his work during the early stages of the War, he was promoted Major-General for Distinguished Service in the Field, dating from 26th October, 1914, an honour he received in company with nine other officers, whose names, like his, were brought to notice in Sir John French's dispatch of 8th October, 1914.

Sandbach was not made C.E. of the 2nd Army on its formation, and in May, 1915, was ordered home to be Inspector of Engineers, where he did a lot of useful work in helping the R.E. units of the new armies which were being raised all over England.

He, of course, wanted to get back to France again, and it was a step in that direction when he was given the command of the 68th (Welsh) Division, then belonging to the Central Force and located at Bedford. He held this command from November, 1915, to 13th February, 1916, when he took over the command of the 59th Division.

The 59th Division, which had been in existence for fourteen months, was the second-line North Midland Territorial Division, and was the first of the second-line divisions to be ready for training for overseas. The Division had its three brigades at St. Albans, Harpenden and Watford.

In April, 1916, when the Easter rebellion occurred in Dublin, the 59th Division was the mobile division for home defence purposes, liable to be sent at short notice to any threatened point, and for this purpose rolling stock was held ready in its vicinity.

Orders were received on Easter Monday (April 24th), directing one brigade to be entrained for an unnamed destination, and the 178th Brigade, under Brig.-General E. W. S. Maconchy, was selected; the Brigade was railed to Liverpool, where it embarked, and where the officers first heard of their destination; efforts were made at Liverpool to buy as many maps of Dublin and its vicinity as possible, but so hurried was the whole thing, that a large proportion of the Brigade were surprised to find themselves landing next day in Ireland, and not in France, and to hear English and not French spoken by the inhabitants.

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The 178th Brigade reached Kingstown at dark on Tuesday, April 25th, and disembarked at 10.15 p.m. that night.

It is beyond the scope of this memoir to describe the happenings at Dublin in Easter Week, 1916, enough only will be said to explain the participation of the 59th Division.

Although there had been in existence for some time in Dublin armed organizations known as the Irish Volunteers, and the Citizen Army, which were wont to parade from time to time, the Civil Authorities and the Police never anticipated any rising.

It came, therefore, as a great surprise, when, at noon on the Easter Bank Holiday, armed bands of the Volunteers and the Citizen Army, parading as for a route march, took possession of important points in the city, whilst a provisional Government proclaimed an Irish Republic. The General Post Office and some of the railway stations were among the places seized, but an attempt to take possession of Dublin Castle failed: fortunately, too, the telephone system was left undisturbed, and by its means the military authorities were able at once to grapple with the situation, and to utilize to the full the few troops quartered in Dublin. There was a Reserve Dismounted Cavalry Brigade in proximity at the Curragh, and this was brought up to Dublin the same afternoon, and its Commander, Brig.-General Lowe, was placed in charge by the G.O.C.-in-C. of the active operations in the city.

The troops available, however, were small in number for the task in hand, and the arrival of the leading Brigade of the 59th Division at Kingstown, on the night of Easter Tuesday, April 25th, must have been very welcome to Irish Headquarters, which at once issued instructions to General Maconchy. He was to dispatch on Wednesday, April 26th, two battalions *via* Stillorgan, west of Dublin, to Kilmainham, where Headquarters were situated. The other two battalions were the same day to move direct on Dublin *via* Balls Bridge, Northumberland Avenue and Merrion Square. He was also to send a detachment to Arklow to guard the Munition Factory there. The Arklow Detachment and the two battalions directed on Kilmainham reached their destinations without opposition, and the same was the case with the other two battalions as far as Balls Bridge, which, situated on the S.E. outskirts of the city, is famous as giving its name to the grounds where the Dublin Horse Show is annually held.

As soon as a further advance, however, was made from Balls Bridge by Pembroke Road and Northumberland Road, in the direction of the bridge crossing over the canal which leads towards Merrion Square, it was resolutely opposed by riflemen in occupation of houses along the route. The fighting became severe, the locality was unfamiliar, and the troops were inevitably much exposed: the progress was necessarily slow, and it was not until after nightfall that possession was obtained of the required crossing over the canal.

The losses had been heavy, five officers and 150 other ranks, but

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these previously untried and only partly-trained soldiers (only a small proportion of them had ever fired a service bullet) had shown great gallantry, and nothing could have been better than the way in which they had come through their baptism of fire.

Meanwhile, subsequent to the dispatch of the 178th Brigade, the G.O.C. 59th Division received orders that the remainder of his Division was to follow. The Staffordshire Brigade (No. 176), under Brigadier-General Carleton, was the next to move, and landed on the 26th (the day of the fighting), and moved on to Balls Bridge that afternoon, whilst the Brigadier, now the Senior Officer of the Division on the spot, got into touch with General Maconchy and Irish Headquarters. As a result, the freshly-arrived Brigade took over the positions occupied by the battalions of the 178th Brigade, which had been so heavily engaged, and these latter were directed the next day on Kilmainham to rejoin the two battalions of the Brigade already there. This movement was duly effected on the 27th, with some fighting *en route*.

The two Brigades now worked under the orders of Brigadier-General Lowe, and took an active and effective part in the fighting which terminated on Saturday, April 29th, when a surrender was enforced.

By this time the casualties of the Division reached a total of 207, including five officers killed and 19 officers wounded, figures which indicate the severity of the ordeal which these young troops successfully underwent.

The remainder of the Division landed at Kingstown on the 27th and 28th, and, on the morning of the 29th, the Divisional Headquarters moved on Balls Bridge just as the surrender was being arranged.

From Balls Bridge, the Headquarters of the Division moved to the Chief Secretary's Lodge in Phœnix Park, where the Division was collected. Sandbach took over the command of all troops in Dublin, and it fell to his lot to provide the courts-martial to try the prisoners and later to arrange for the execution of those that underwent the death penalty. He had also to administer martial law for a period, issue proclamations under the Defence of the Realm Act, and arrange for a special system of passes for controlling the movements of the civil population.

The Division was almost immediately split up again; early in May the 177th Brigade was sent to Fermoy, the 178th to the Curragh (whither D.H.Q. also went), whilst the 176th Brigade had two battalions at Dublin and two in Belfast. This scattered distribution was maintained all through the remainder of 1916, and, with the detachments under Local Area Commanders and largely removed from divisional guidance, it is easy to see how enhanced were the difficulties of preparing the Division for France—a task rendered still harder by the units having to furnish drafts for the first-line Division

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at the front. Sandbach, we may be sure, did his best, but it came as a great relief when, in January, 1917, the Division was moved to Fovant, near Salisbury Plain; every nerve was now strained to make the most of the time and opportunity: on February 13th the Division was inspected by H.M. The King, and ten days later it proceeded to France, landing at Havre on February 24th, and two days later the Headquarters were established at Mericourt sur Somme.

Special difficulties seem to have faced the Division in France, as at home. It was not possible to give it time to train at one of the rest areas, and early in March it was sent straight up into the line in the 3rd Corps, south of the Somme, near Estrees, with Headquarters at Foucaucourt, and here it experienced its initiation into the mysteries of trench warfare.

The Germans, however, suddenly retired across the Somme about 17th March, and, of course, the British troops at once pushed forward in pursuit. "General Sandbach had then to conduct 'above ground' operations, the first of the kind since Mons, Le Cateau and the Marne. He tackled this with enthusiasm, and effectively, and, in order to keep his troops moving, he obtained a Second Divisional Train and an additional Ammunition Column.

"The Division now felt its lack of training, for it was engaged in a very difficult operation, necessitating ceaseless and bold patrolling and constant initiative on the part of Brigade and Battalion Commanders. Tactical situations were difficult enough, but in addition the utter absence of communications had to be contended with."

Jeancourt was captured after a fine attack on the 31st March, 1917, but a subsequent attack on Le Verguier on 2nd and 4th April, and another on the 5th and 6th, were repulsed.

These attacks were costly, and it was not perhaps realized when they were ordered that the position attacked was part of the Hindenberg Line. It was never captured until the final advance at the end of the War.

The difficulties which Sandbach and his Division had to face were immense, and they were tackled with courage and enthusiasm.

It seemed, however, to the Army and Corps Commanders that the public service would gain by the employment of a younger man, and one with more recent fighting experience, to command the 59th Division, and so, on 10th April, 1917, Sandbach handed over his charge to his successor, Major-General, now Lieut.-General, Sir C. F. Romer, and returned to England on half-pay.*

After his return from France, Sandbach, with plenty of younger men available, was not further employed, and he finally retired on the 19th August, 1919.

With the exception of a couple of years spent abroad, Sandbach

* For the account of Sandbach's connection with the 59th Division the compiler is largely indebted to the Records of that Division, supplemented by information kindly given by Lt.-Col. C. U. Bradbridge.

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spent the remainder of his life at Bryn Gwyn, where he found plenty to do. For many years, despite his active military career, he had taken a keen interest in the affairs of Montgomeryshire. He had become the first Chairman of the Montgomeryshire Territorial Force Association after the passing of Lord Haldane's Act in 1908, and he retained the post until 1920. It was in no small measure due to the enthusiasm which he inspired that Montgomeryshire was one of the first counties in the country to recruit its Territorial units up to strength.

He was a Deputy Lieutenant for the county, and filled the office of High Sheriff in 1919. The following extract from a local newspaper gives some idea of his county activities :—

> " After the War, General Sandbach threw himself unsparingly into work in the interests of ex-Service men. He was a member of the Disablements Committee of the Montgomeryshire War Pensions Committee, now disbanded, and was appointed as one of the Joint Pensions Committee set up for the combined counties of Denbigh, Flint and Montgomery. The Comrades movement in Montgomeryshire was largely kept in existence as an active organization through his zeal as Commandant. He took a leading part in the amalgamation of the various ex-Service men's organizations into the British Legion, and he acted as a member of the National Executive and as President of the Welsh area. He was also a leader in the Boy Scout movement. He acted as Commissioner for Montgomeryshire, and troops of Scouts which had the good fortune to train at Bryn Gwyn found in General Sandbach one who was a fine example for boy hero-worship. He was a zealous Churchman, and one of the original members of the Representative and the Governing Bodies of the Church in Wales. He was a Governor of the University College of North Wales, Bangor, a member of the Montgomeryshire Agricultural Committee, and a member of the Welsh Consultative Committee of the Forestry Commission."

His Grace the Archbishop of Wales has supplied the following appreciation of Sandbach's connection with the Church of Wales :—

" In any record of General Arthur Sandbach, there would be felt omission if some testimony, however inadequate, were not borne to the place and influence which were his in his own home and among his countrymen. He was a distinguished and much-respected figure in Wales. A Welsh soldier and neighbour described him as ' every inch a gentleman, and his very presence was enough to make him respected.' This description, so spontaneous and uninspired, was in simple words simply true. There was a charm of manner and address which attracted those who knew him, and his friends recall the generous kindling of his glance, and the fascination of his smile. His home lay amid a circle of mountains, and the valley through which it was reached was full of beauty and romance. At the foot

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of the hill, upon which his home, 'Hafodunas,' stood, lay the village and church of Llangerniew, which, translated, means 'the Church of the Cornishman.' Whatever the link may be between it and Cornwall, Llangerniew, one of the oldest and most interesting churches in the country, dates from the middle of the fifth century.

"Arthur Sandbach took a lively and sustained interest in the well-being of the church and village, and it was in one of the many church gatherings there that I first saw him well nigh forty years ago. One evening on which we both met soon after his return from the South African War was spent in a vivid description of the passage of the Tugela, and then he passed to an enquiry about the doings of the Church in Wales, at that time on the edge of fortune. So it was during the Great War that he watched the struggles of the Church in Wales with undiminished concern. When he retired from active service, he took a foremost place in the wider field of ecclesiastical affairs in Wales. The first years of the disestablished and disendowed Welsh Church called for the loyalty and the active service of its sons. The task before Welsh Churchmen involved an almost intolerable strain upon resources depleted by the Great War, and upon an unequalled sacrifice in time and service. Even more arduous still was the reconstruction of the oldest Church in Britain, severed from its younger and far more powerful sister-church in England. The first step taken in this great task was the assemblage of a convention at Cardiff in October, 1917, constituted of representatives, lay and clerical, of the whole Church in Wales. Foremost among the representatives was General Sandbach. During the four days at Cardiff, the outlines of the task were clearly drawn. When details were reached, it soon began to be realized that the centre of gravity had shifted, and that undreamt of difficulties and problems of the utmost complexity daunted the stoutest hearts.

"Committees of clergy and laity were chosen to deal with these specialized problems. The work demanded regular attendance and careful study of the problems to be solved. This went on for five years. The toil bestowed upon it was beyond all praise. General Sandbach, from the day of the convention until the day of his death, never failed to take a leading part in this work. In the debates at the meetings of the governing body of the Church in Wales, and in the administration of the resolutions therein taken, his unfailing presence was an inspiring example. This distinguished soldier, trained in a school of order and discipline, never spoke in vain, and in the fewest possible words helped to clear obscurities or to bring to light important points that had escaped observation. The record of the part he took in Church matters resembled in character his activities in the general life of Wales."

Major-General Sir Hugh Elles, who, when a Captain, was his Adjutant at Aldershot, and who visited Sandbach at Bryn Gwyn, writes: "I stayed once with him at his place on the border of Wales;

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a most delightful and assiduous host, and in his county held in high respect. He certainly was a devoted county man and worked tremendously hard at all the things for which the county magnate gets no pay and very little thanks."

The same writer goes on to say: "As a young soldier I always understood he was ambitious; I never saw much trace of that myself; if his ambition persisted, he certainly took the curtailment of his career with great philosophy."

The above is interesting as throwing a side-light on Sandbach's character.

Those of us who knew Sandbach in his younger as well as in his later years realize that an honourable ambition to succeed as a soldier was from first to last one of the keynotes of his outlook on life; he followed Robert Burns' advice:

> To win Dame Fortune's golden smile,
> Assiduous wait upon her
> And gather gear by every wile
> That's justified by Honour.

But in spite of this characteristic, there were things in life that had higher values for Sandbach than gratified ambition, and it was to this fact that he owed his unfailing dignity of character; for this reason he was never unduly cast down by failure or elated by success; he never adopted a complaining attitude, but, making the best of life, played the game to the end.

By the death of his eldest brother, which occurred early in 1928, Sandbach succeeded to the family place, Hafodunos in Denbighshire, a very fine property, where he had been brought up as a boy, and where he had learnt to hunt, shoot and fish.

Sandbach had one child, a daughter named Geraldine, to whom he was devoted, and for whose benefit he wrote the notes of events in his early life which have been utilized in this narrative; it was mainly on her behalf that her parents took a house in London for the season in 1927 and 1928.

On the second occasion Sandbach became unwell shortly after reaching London; he then contracted pneumonia, from which he seemed to be slowly recovering when his death occurred unexpectedly on June 25th, 1928, when he was within a month of completing his 69th year. He was buried three days later in the churchyard of Bwlchycibau Church, close to his home, and the large attendance of all classes in the neighbourhood bore testimony to the affection and respect entertained for him by those among whom the closing years of his life had been spent.

The Corps of Royal Engineers was represented by a senior officer, and a party of R.E. trumpeters from Aldershot attended and sounded the "Last Post."

H.M.L.

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PROFESSIONAL NOTES.

A RECENT DEPARTURE IN THEODOLITE DESIGN.

THEODOLITES are of such general use in all branches of engineering that no excuse is made for describing a new type of these instruments. The majority of Sappers are probably most familiar with the type of instrument which had its circles divided on silver arcs and in which the micrometer or vernier arm clamped directly on to the accurately divided circle. The great disadvantage of these instruments was that they weighed a great deal and that the micrometer arm had to be levelled before making a vertical observation and that the clamp was likely to bend the vertical circle. In recent years the latter two defects have been overcome by re-adopting an obsolete design in British practice of clamping the telescope directly to one pillar of the instrument, and leaving the micrometer arm free to be levelled and clamped to the other pillar of the instrument after the setting of the telescope had been made. The former defect was not overcome until the introduction of what may be called the " glass " theodolites.

The " glass " theodolites are here so termed because their essential difference is in the fact that their arcs are divided on glass and the system of reading is by optical means brought to one eyepiece in proximity to the telescope eyepiece. Examples of these instruments are the " Wild Universal Theodolite," " Wild Precise Theodolite," " Zeiss Theodolite," " Watts-Zeiss Theodolite " and " $3\frac{1}{2}$" Double reading Theodolite (Cooke, Troughton and Simms, Ltd.)."

The characteristic features of these instruments are that they give similar magnification and light collecting power to the normal 6" or 8" theodolites with a smaller and lighter telescope, that the arcs are totally enclosed, that the mean of the readings on opposite sides of the arc can be read with one setting of a micrometer visible from the observation standpoint, that both arcs can be read from the same position and with the same micrometer, and that the bubble can be set after the telescope has been set, and viewed from the observation standpoint. These great simplifications in reading have been achieved by an elaborate system of lenses and prisms and in most cases a parallel plate micrometer, all incorporated in the body of the instrument and of fixed adjustment.

The advantages of these instruments over the latest patterns of the normal theodolites are :—

(i) much less weight and bulk for the same precision, and

(ii) observation and reading are possible from the same standpoint, resulting in a saving of time and less disturbance of the instrument during reading.

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The disadvantages are that, with the exception of the bubble adjustment, all parts are fixed in maker's adjustment, with the result that in the event of a displacement of the optical arrangement the instrument is probably rendered useless. The precision of manufacture, however, renders this very unlikely. Further repetition readings on a subtense bar cannot be taken.

The following is a summary of the types of "glass" theodolites mentioned above :—

Wild Universal.—Weight of instrument about 9 lb.
Micrometer reading direct to 1 second horizontal arc.
Micrometer reading direct to 2 seconds vertical arc.
Bubble sensitivity, 16″ per millimetre.*
Range of 32 readings of one arc setting (vertical), 1·7″.
Probable error of single astronomical reading, including setting and stop-watching, 1·9″.

The telescope transits eyepiece up only. A diagonal eyepiece is fitted, but no star sights. Two lenses of the reading system are exposed to the atmosphere, rendering condensation possible. Only stars up to 60° elevation can be observed.

"*Wild Precise*" is a larger and more accurate instrument of the same type.

"*Zeiss.*"—Weight of instrument, about 10 lb.
Micrometer reading direct to 1 second both arcs.

The telescope transits eyepiece up only. An object glass prism is fitted for high star sights; this cannot be collimated. No star sights are fitted. The reading telescope does not travel with the sighting telescope. Only stars up to 60° elevation can be observed.

"*Watts-Zeiss*" *or* "*Monocular Micrometer.*"
Weight of instrument, 10 lb.
Micrometer reading to 1 second both arcs.
Bubble sensitivity, 9″ per millimetre.*
Range of 5 vertical readings, 4·2″.

The telescope transits object end up only. A diagonal eyepiece is fitted and also star sights. All altitudes of stars are observable. One end only of the bubble is set to a mark, the error from expansion of the bubble may thus rise to the order of 1 second in the tropics. The reading telescope does not travel with the sighting telescope.

"*Cooke, Troughton and Simms.*"—Weight of instrument, about 11 lb.
Diagonal scale reading direct to 10″ both arcs.
Bubble sensitivity, 5″ per millimetre.*
Range of a number of readings (no. unknown), 10″.

* N.B.—With the same accuracy of a single setting, a less sensitive bubble gives a greater rapidity in reading.

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The telescope transits either end up. A diagonal eyepiece is fitted. The reading is by diagonal scale. All altitudes of stars are observable.

A new model of this theodolite is being made with a micrometer reading attachment designed by Capt. Baker, R.N., which should give readings comparable to the Continental instruments.

D. R. CRONE.

"EMERGENCY WATER SUPPLY IN WAR TIME."

IN the *Military Engineer* for May–June, 1929, appears an article entitled "Emergency Water Supply in War Time." This describes the application of a system of water supply which is in use for the irrigation of the Arkansas ricefields to the case of a training camp required in a hurry. The principles employed are the same as those used now in many cases for obtaining water for cantonments in Northern India, and a description of these principles and of the differences in their application in the two countries is of interest.

In Arkansas, the water is obtained from wells driven to an average depth of 140 feet. From the surface of the ground to a depth of about 80 feet there is an impervious stratum of clay. Below this comes the water-bearing stratum of some 40 feet of fine sand. In the first endeavours to obtain water from these sands, an eight-inch pipe was driven down into the water-bearing strata. A brass tube in which fine slots had been cut was then lowered inside the pipe and placed at the bottom: the pipe was then raised sufficiently to expose the brass tube to the sand, and a pump installed in the bottom and set to work. The object of the slots was to keep out the sand and admit the water, the slots being necessarily smaller than the grains of the sand. As long as only a small amount of water was required, things went all right. But when large quantities were wanted, the velocity of the water caused the sand to pack all round and in the slots. This reduced the yield to such an extent that the wells had to be abandoned.

In the next attempt the slots in the strainer were made wider, and the results were again unsuccessful. The sand came through with the water so much that cavities were formed round the strainer, and eventually, the support of the clay stratum above having been removed, this stratum caved in and the well was wrecked.

The final successful solution of the problem is the "gravel-wall well," and is described as follows:—

A large-diameter surface caisson is driven from the surface of the ground to the top of the water-bearing sand stratum, from which it is proposed to develop the water supply. A smaller-diameter perforated pipe of sufficient length to penetrate the water-bearing stratum is prepared. On the bottom of the pipe in question is

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attached a large perforated cone. The bottom diameter of this cone is large enough to fit loosely inside the surface caisson.

This cone forms the cutting edge for the perforated pipe or strainer and also a footing for the gravel wall. The perforated pipe with cone attached is lowered inside of the surface caisson until its larger diameter rests on the top of the water-bearing stratum at the bottom of the surface caisson. To the top of this strainer are attached sufficient lengths of pipe to extend above the surface of the ground.

The annular space between the two casings is then filled with carefully screened coarse gravel, forming a wall of coarse gravel around the screen. The water-bearing sand beneath the bottom of the cone is then removed by means of a plunger bailer or sand pump, and, as the sand is removed, the screen with its surrounding gravel wall, settles down through the water-bearing stratum.

This process is continued until the strainer has entirely penetrated the water-bearing stratum. Additional lengths of pipe are added at the surface as the screen settles through the water-bearing stratum, and additional quantities of gravel are introduced in the annular space between the casings.

After the screen is installed a plunger, fitting the inner casing and screen closely, is operated, in order to wash the water back and forth through the openings in the screen, and thereby draw all loose, fine sand possible into the screen, from which it is removed by bailing. As this sand is removed, the coarse gravel feeds down between the casings, filling any voids which may be formed around the screen, and thereby preventing the caving in of the impervious stratum by reason of the removal of the support below.

After all possible sand is removed in this manner, high-capacity pumps are installed in the inner casing and the well is surged and pumped at a high rate of speed to remove additional sand, and secure the introduction of more gravel around the screen.

The openings in the inner strainer are quite large, because this strainer acts only as a support for the gravel wall—the separation of the sand and water occurring at the outer diameters of this gravel wall. The result of this is a greatly increased capacity of production of water, flowing through coarse openings in the screen at a low velocity. This method has revolutionized the production of water from underground sand strata, and is now being used quite extensively in municipal supply. An illustration is given in the article of such a well which gives a supply of 25,000,000 gallons daily.

In India a similar problem existed of obtaining from water-bearing sands underlying an impervious stratum a supply of either drinking water for cantonments and municipalities, or of water for irrigation purposes. The problem was tackled some twenty years ago by two engineers, Messrs. Brownlie and Ashford. Two different tubes or strainers were evolved; the Brownlie strainer is a

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slotted brass tube similar to the American pattern, whilst the Ashford tube consists of a framework bound round with copper wire, the turns of which are spaced according to the quality of the sandy stratum. The method of sinking is as follows:—A four-inch plain tube is sunk as a bore to obtain samples of the strata passed through. If any of these are water-bearing, they are tested by the Kennedy method, and from the results obtained it is possible to give a fairly accurate idea of the amount of water it will be possible to obtain and to determine the size of the openings in the strainer. From the test bore it is calculated which of the two standard sizes of strainer, five-inch or ten-inch, it is necessary to use. Assuming that a ten-inch diameter strainer is needed to give the yield required, then a twelve-inch plain tube would be sunk to the necessary depth. This tube has flush joints inside and out, to facilitate sinking and withdrawal, and to avoid damage to the strainer whilst it is being lowered inside the tube. To standardize manufacture, the strainer in the case of the Ashford patent is wound with a standard spacing between the turns of the copper wire, so that if the samples show a sand of unusual fineness, it is necessary to take precautions against the fine sand being drawn into the well, cavities forming, and the well eventually failing. This is provided for on very similar lines to those adopted in America, in the "gravel wall." Coarse sand is poured down between the outer casing and the strainer. When the plain tube has reached the requisite depth, the strainer is lowered inside it and kept suspended until the plain tube has been withdrawn and the soil has closed in round the strainer and removed any danger of strain, and consequent distortion and disturbance of the copper wire turns. The tube well in its completed form consists of the strainer in the water-bearing strata, and a plain tube in the strata which are not water-bearing. At some point in the plain tube, depending upon the local water conditions, is placed the pump, of which special forms have been designed for use in these tube wells.

The principle that underlies all successful getting of water from water-bearing sands is that the critical velocity of the water for the sand in each case must not be exceeded. This critical velocity varies in accordance with the conditions of each well. In an open surface well in India, for instance, the critical velocity is reached when the well is working under a depression head of 5 to 7 feet. That is to say, when, the water in the well having been lowered to this extent, there is a difference in level of 5 to 7 feet between the water in the well and that immediately surrounding it. If this critical velocity is exceeded, the finer particles of sand will be carried along by the water into the well, and the well will "blow." If the process is continued long enough, a cavity will be formed under the curb of the well, the steining will crack and the well will be ruined. This is a point which should be well understood; an officer is sent

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out to test the water supply from the village or other wells in a certain area ; unless he knows this principle, the first thing he will do probably will be to pump a well completely dry. What he should do, if he wishes to test the rate of yield of the well, is to lower the water in the well by not more than 7 feet. Under that head it will be found that the critical velocity is about one-half foot per minute. Normally, therefore, the yield of a surface well is comparatively small, and depends on the area of the bottom of the well.

In the case of a tube well under the usual conditions in India, the critical velocity may be as much as half a foot per second, or sixty times as much as in the case of the open well. The reason for this is that the conditions of supply differ widely. The supply in this case is what may be called sub-artesian and the water normally will rise to a point fairly high in the plain tube above the strainer. What are the conditions which exist when the well is being drawn upon to its full capacity ? Any cross-section of the strainer is the centre of a circle, from the circumference of which water flows towards the strainer at an ever-increasing velocity. On the circumference of this circle, the water is flowing towards the tube at a velocity which is just sufficient not to disturb the lightest grains of the sand ; as the water flows towards the tube the velocity gradually increases till it reaches its maximum at the entry to the tube itself. In the process the smaller grains of the soil are washed into the tube and pumped out, and when a state of stability has been reached in the maximum flow into the tube, the soil within the circle affected is arranged approximately with a state of increasing coarseness from the circumference inwards towards the tube at the centre.

It is interesting to observe that it has been demonstrated mathematically by Mr. F. Temple, an engineer in India, that by grading the material scientifically, it is possible to pack the bottom of an ordinary open infiltration well in such a way that the fine grains of sand cannot be washed into the well, however hard the water is pumped, and therefore the well cannot blow.

The practical side of tube well sinking as practised in India is fully set out in Volume IV of the *Military Engineer Services Handbook.*

P.H.K.

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BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914-18.

VOL. III.—THE A.I.F. IN FRANCE, 1916.

By C. E. W. BEAN.

With 475 illustrations and maps. (Angus & Robertson, Ltd., Sydney, 1929. Price 21s.)

This work will eventually reach a total of twelve volumes, of which Vols. I, VII, IX, X, and XII have been published. We now have Vol. III, which deals with the reorganization of the Australian Forces in Egypt after Gallipoli, their early experiences in trench warfare in France, and the part taken by the 1st, 2nd, 3rd and 5th Australian Divisions in the Battle of the Somme. As indicated in the Preface, the latter, and larger, half of the volume is written somewhat in the style of a "divisional history." Mr. Bean goes in great detail into the incidents of the fighting on the Australian front, makes it interesting by the introduction of the personal touch, and builds up his story rather on diaries, letters, and personal interviews with participants in the fighting, than on official reports and dispatches. These interviews were obtained within a few weeks of the events that he describes, and the author claims that they enable him to produce a much truer and more accurate account of what actually happened in the front line than could possibly be gleaned from staff diaries and official documents. To a certain extent he may be right, but it would be useful to be able to refer to more of the operation orders, especially of the lower units. The result, however, is—despite its 967 pages—a very interesting and instructive narrative, which he hopes will assist military students to arrive at the causes which have made the Australian soldier what he is, and help them to understand his characteristics and appreciate his good qualities. Mr. Bean apologises for the method he has adopted. The book, he explains, is written for home consumption in Australia as well as for the world at large. Colonials, he says, are sceptical of official reports and dispatches. Well they may be when these are "written up," with the aid of the official newspaper correspondent, with one eye on the effect they will have on the Dominion concerned, but the truth is that the official reports of untrained staff officers are apt to be sketchy, if they exist at all. Mr. Bean devotes a dozen pages of his volume to a subject on which Australians are touchy—the question of discipline. Discipline depends on the officers from the highest to the lowest in rank. The Australians were exceptionally fortunate in the senior officers of the Regular Army, who, by reason of previous service in the Colonies, or by selection, were appointed to command them. British officers, he says, unaccustomed to dealing with the independent and well-hardened types which composed

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a large part of the Australian Forces, were shocked at their behaviour, drunkenness, and rowdiness in Egypt. The trouble was not confined to the men. There was a large number of unsuitable officers who were gradually eliminated. There were, he admits, regular officers serving with the Australian troops who thoroughly understood them, but there were others who never would. To anyone who served with Australians in South Africa, there was no difficulty in dealing with them in France. There are many ways of enforcing discipline. Mr. Bean gives us an amusing example. " A large number of Australians were, after Gallipoli, " in camp at Tel el Kebir. They were somewhat disappointed at finding " themselves, on their return to the comforts of civilization, camped so " far from Cairo. Every day two per cent. of the men in each unit " were given two days' leave to Cairo. There occurred a certain amount " of breaking out of camp, and overstaying of leave was fairly common. " The latter offence did not argue any very criminal intent, most of the " men being quite ready and willing to pay for a slight extension of their " holiday. Wise commanders for the most part recognized this fact. " For example, Lt.-Col. (afterwards Major-General Sir John) Gellibrand, " then commanding the 12th Battalion, when some of these cases were " brought before him, used to surprise the truant by asking: ' Well, " ' have you had a good time? ' ' Yes, sir.' ' Did you enjoy yourself " ' thoroughly? ' ' Yes, sir.' ' Of course, you don't object to paying " ' for it? ' ' No, sir.' There would follow a fine or other punishment, " which, though sometimes moderately severe, was accepted in the spirit " in which it was given."

There would have been no difficulty about discipline had the Australian authorities been stronger in dealing with the bad characters. " At " Tel el Kebir," continues Mr. Bean, " it has become obvious that there " had been enlisted a certain number of criminals, some of whom had " entered the force with the intention of running gambling ' schools ' or " of escaping from punishment in Australia. As time went on, it was " found that many of these men had no intention of reaching the firing " line. They were a mere handful in number, and gradually became well " known to their officers and their comrades; but their presence, now " first noted, was the cause of atrocities which occasionally blackened " the name of Australia. As the Australian Government about the " middle of 1916 indicated that its policy was against the return of men " to Australia for disciplinary reasons, the A.I.F. was forced as far as " possible to digest its own bad characters, and the existence of these " men afforded a problem increasing in difficulty as the war went on."

The Suspension of Sentences order did not help the Australians in dealing with these bad characters. Mr. Bean omits to mention this, nor does he refer to the fact that the Australian Government had abolished the death sentence for military crimes, except in the case of treason and desertion to the enemy.

As regards minor indiscipline, *e.g.*, the failure to salute officers, Mr. Bean devotes three whole pages to the subject, and after attributing the failure of the Australian to his democratic bringing up, concludes as follows: " The precise forms of discipline suited for a nation imbued " with the feudal tradition were not found to be, in their entirety, well " suited for such people as Australians, among whom the sharp social

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"distinctions and inequalities of the older nations are practically non-existent." It is well to mention this subject, for it may help officers serving with colonial troops. Whether they will be convinced by Mr. Bean's explanation is doubtful, but they should read it.

It is impossible to say much in a short review as to the rest of the volume. The detailed accounts of the raids carried out in the course of normal trench warfare by the Australians, and by the Germans in retaliation, and the narrative of the Somme fighting, will serve for all time as a classic for military students. Illustrated as they are by numerous sketches in the letterpress, they are easy to follow, and afford, in a manner in which no other writer has been able to do, a real insight into the difficulties of modern warfare. The descriptions of the fighting at Fromelles, and for the Pozières ridge, are a remarkable testimony to the fighting qualities, the individual initiative, the resource, the tenacity and the courage of the Australian soldier. It is almost inconceivable that any troops could have gone through what the Australians did day after day for weeks without damaging their morale. That they felt it, Mr. Bean admits, but only temporarily, and by the end of 1916 the survivors had entirely recovered their cheerfulness and morale. We hear nothing of shell-shock and the lasting effects to which soldiers of a less virile type were victims. If the system of wearing down the enemy by attrition can be deemed to have been justified by success, full credit must be given to the Australians for their share in the Battle of the Somme. To anyone who served with the Australians in South Africa, their achievements in Gallipoli, in France, and in Palestine came as no surprise. The wonder is that, after losing so many of their best officers and men in Gallipoli—the 1st Australian Division lost half its strength—they were able to produce and train the large number of officers and N.C.O.s required for the expansion of the Australian Imperial Force (A.I.F.), which eventually reached the equivalent of seven divisions.

The volume is well illustrated, provided with numerous maps and sketches, and a very complete index. If any officer or man is mentioned in the narrative, a footnote is inserted giving his place of birth, age, profession and place and State of origin. Though many of the heroes came from the back-blocks, there were many from amongst the well-educated professional men of the cities.

H.B.-W.

THE DEFENCE OF BOWLER BRIDGE.

By H. E. GRAHAM.

(William Clowes & Sons, Ltd., 3s. 6d.)

This "study of minor tactics" is a worthy offspring of the *Defence of Duffers Drift*, a classic to which the author freely acknowledges his indebtedness.

Times change, however, and tactics should change with them, so here is *Duffers Drift* in modern dress, only with a new author, new management and the old charm.

Duffers Drift may be proud of its child.

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When the *Defence of Duffers Drift* was first published, it aroused an interest (which took it into more than 10,000 copies) much in excess of that which might be expected from the study of the action of a subaltern and 50 rank and file holding a drift across the Silliaasvogel River.

That was due to the author's skill in " painting the picture," and so creating the atmosphere which surrounds any commander of an independent mission far from the comfort of being suitably *encadré*. In consequence, big lessons were learnt from a small story—and perhaps the biggest lesson was how a military problem should be approached in practice.

Now we have a new Duffers Drift. The Silliaasvogel River has become Rasberry River, Duffers Drift is Bowler Bridge, Incidentamba and Regrettable Mountain are transmuted into Fiddleton-Homburg and Topper (sinister civilian headwear suggestive of Stellenbosch to an older generation). But the atmosphere of doubt and perplexity remains, as does the " everlasting miracle " by which Augustus Sydney Smith—whose parents were almost as careless at the font as those of the defender of Duffers Drift—gets a second and a third and a fourth chance to rectify his earlier errors. Each failure equips him with fresh knowledge and the sum total produces success, as at Duffers Drift.

Though times and weapons have changed, Augustus Sydney Smith is not much better off than Backsight Forethought was nearly 30 years ago. He disposes of a somewhat greater fire power but fewer men. In addition, he has an A/T gun of a more efficient pattern than has yet appeared. He also has Serjeant Bass, D.C.M., M.M., whom to know is to love, but who, like the addition in the story, " makes it harder."

His enemy is just as numerous—just as aggressive, as mobile and as slim, but for the " hippo mobility " of 1900 has been replaced the automobility and armour of 1929. The progress of invention, at first seeming, has made things even more difficult for the B.F.s and A.S.S.s who still optimistically command infantry platoons. The author, however, proves that this optimism is not so unfounded as it would appear.

The story is admirably told. There is not a dull moment. All sorts of valuable hints and ideas slip in among the more outstanding tactical events and lessons. The diagrams are good and give a clear idea of the ground. The book is recommended to any soldier who is working for the Staff College or for a promotion examination, or to those who, with single-minded devotion, desire only to improve their knowledge of their profession. A young officer could leave it safely in the hands of his parents.

No reader can fail to find it at once amusing and instructive. The greatest amusement and the best instruction will be got if the reader prepares his private solution to A.S.S.'s problem before reading on after page 7 or looking further than Sketch No. 2. It is possible that the professional tactician may find that Bowler Bridge is a *pons asinorum*. Try it on your friends.

Finally, I suggest that *The Defence of Bowler Bridge* has a particular interest for Royal Engineers. The bridge must not be blown up, but equally it must not be used by the enemy's A.F.V.s. The problem of making road blocks against A.F.V.s., which arises out of those conditions,

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is a baby which is frequently passed to the Army's professional nurse for unpleasant children which nobody else wants, the Corps of Royal Engineers.

E.E.D.-S.

RECORDS OF THE SURVEY OF INDIA, VOL. XXII.

"THE EXPLORATION OF THE SHAKSGAM VALLEY AND AGHIL RANGES. 1926."

It is probable that most of the professional papers (now called "Records") of the Survey of India have been published for the instruction, rather than for the entertainment of the public. This must not be taken to imply that entertainment is not to be found in them or that their contents are unintelligible to any but those already well instructed in the subjects of which they treat. Far from it. Nevertheless, it is probably true to say that such entertainment as may be found in them is incidental to the primary object.

In this volume this time-honoured practice seems to have been reversed, and we have an interesting account by Major Mason, quite in the popular style, of his recent expedition to the Shaksgam Valley. The fulfilment, he tells us, of a "long cherished personal ambition" to fill in the last considerable blank in the map of the Karakoram.

The book, however, is much more than a story of travel and adventure in high mountains. It includes appendices on rations, supplies, clothing, equipment and transport, as well as one on geographical names, and the account is made to form a peg on which to hang a proposal for the revision of the nomenclature of this famous region.

In his preface, Brigadier Tandy, the Surveyor-General of India, refers to this proposal, and says, "The proper name assigned to this area is thus a matter of considerable (*sic*) interest." He adds that "From these discussions it appears quite clear that the Karakoram range is really a misnomer which has arisen from a series of misunderstandings," and concludes with an appeal to the Royal Geographical Society to arrive at a decision as to what name should be placed on future Survey of India maps.

This appeal will come as rather a shock to those who consider that, for deciding controversial points in national nomenclature, the National Survey should be a better authority even than so distinguished and competent a body as the Royal Geographical Society. They will not be surprised that the proposals come in for severe criticism from Colonel Sir S. Burrard, a former Surveyor-General of India and a leading authority on Himalayan geography, who points out in the September number of the *R.G.S. Journal* that the present nomenclature, far from being due to any misunderstanding, was only adopted by the Survey of India after the most careful consideration by geographical experts whose familiarity with this region was many times greater than that of any man living at the present time.

The actual account of Major Mason's journeys (for which the R.G.S. awarded him its Founder's Medal), though embellished with occasional rhapsodies on the beauties of dawns or sunsets in these elevated regions,

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is somewhat marred by the difficulty of following the route on the map, from which a great many of the names used in the text are omitted. Indeed, there is no map included on which the movements recorded in the first chapter may be followed at all.

The Shaksgam Valley lies immediately to the north of the high range, containing the peak K.2, the second highest mountain in the world. It had previously been entered from its western end by Sir Francis Younghusband forty years ago. This expedition entered the valley from its eastern and upper end, but, after proceeding about 15 miles down it, was held up by a large glacier coming down from the high range to the south and forming an impassable barrier right across the valley. Efforts to turn this obstacle opened up much new and interesting country to the north, but the shortness of the season compelled a return of the expedition before the Shaksgam Valley had been regained. There is thus a small area of unknown country still left to attract the adventurous.

As regards more technical matters, this expedition was of particular interest in that Major Mason took with him a stereo-photo-topographical outfit prepared by Messrs. Wild and purchased for the expedition by the Royal Geographical Society.

This, it is believed, is the first occasion on which stereo-graphic methods have been used for exploration on any considerable scale, and there may be some who had hoped to find in this paper technical details of the equipment, procedure, or results. If so, they will be disappointed. Some interesting general observations are made, and the text mentions a number of camera stations, but apparently it is necessary to refer to a map published in the *R.G.S. Journal* to discover where and how these were situated, and the areas which were surveyed from them. Perhaps this omission only means that the Survey of India are going to deal with this interesting subject in a subsequent paper.

M.N.MacL.

(*a*) 1915 CAMPAIGN IN FRANCE.

THE BATTLES OF AUBERS RIDGE, FESTUBERT AND LOOS.

Considered in relation to the *Field Service Regulations*.

(*b*) THE OPERATIONS IN EGYPT AND PALESTINE, 1914, TO JUNE, 1917.

Illustrating the *Field Service Regulations*.

Both by LIEUT.-COLONEL KEARSEY, D.S.O., O.B.E., *p.s.c.*, and published by Gale & Polden, Ltd.

(Price 3s. each.)

The lay-out of both these books is the same. The author produces appreciations of the situations, a diary of events, and descriptions of the battles, illustrating *Field Service Regulations*.

It cannot be said that these books achieve the author's aim, as he has tried to do either too much or too little: appreciations are very drawn out and are more like historical dissertations: diaries of events are abbreviated to a point where little of interest is left: and the lessons deduced from the history are very vague.

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In the former book, too, one cannot help feeling that analysis of Aubers Ridge and Festubert, with an eye on *F.S.R.*, is almost a waste of time.

The most disappointing and misleading parts of these books are the appreciations. It is never clear whether they are being made from the point of view of a Cabinet, G.O.C., or local leader, and history of future events is often mixed up with the appreciations. In the appreciation of the situation in Palestine at the beginning of 1916, the plan, such as it is, is decided before considering the possible action of the enemy, and it would certainly not pass the acid test of analysis to see whether sufficient information were provided to enable orders to be written. In this particular appreciation the *object* is given as " to carry out an active defence and to reduce the number of troops in Egypt." The plan is " to carry out an active defence and reduce the number of troops in Egypt." Then the method is discussed.

The lessons deduced to illustrate *F.S.R.* are all too vague, and it is a pity that these books, based on the 1927 *F.S.R.*, should just be appearing at the same time as the new *F.S.R.*, although the principles of the lessons illustrated remain the same. It is irritating, in addition, to find that, presumably owing to financial restrictions, the sketches of battle areas, etc., cannot be read clear of the letterpress.

H.G.E.

ARMY HEALTH IN INDIA.—HYGIENE AND PATHOLOGY.

By LIEUT.-COLONEL JOHN MACKENZIE, M.A., etc., Royal Army Medical Corps.

(John Bale, Sons and Danielsson, Ltd., 10s. 6d. net.)

Thirty years cover a period during which a wonderful advance has been made in medical science, both in prevention and cure. The story of this advance, so far as the Army in India is concerned, is told in this volume of 158 pages, which is blessed in a foreword by the Director-General, Army Medical Services. It so happens that this period, 1899 to 1929, coincides almost exactly with your reviewer's service in India, a service that started with a drastic one-dose inoculation against enteric fever. In 1899, one heard still on all sides of the dreaded ravages of enteric amongst the young newcomers to the country, and the deaths from this cause in the South African War, which started in October, 1899, will be well remembered. Compare with those times the conditions as we know them now, both in peace and war, and the great advance in preventive medicine in this disease alone will be realized.

The earliest available statistics of the health of the Army in India show that, during 1800–1856, the average death rate was 69 per 1,000 of strength. In 1924, the death rate was 4.27 per 1,000. From 1838 to 1856, the average annual admission rate was 1968 per 1,000. Allowing for changes in the system of treating men in barracks, and " detaining " them instead of " admitting " them to hospital, the admission rate dropped below 1,000 per 1,000 for the first time in 1904, when it stood at 900. The year 1911 was a record year, the rate being 524.7 %, the lowest

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figure that has ever been recorded. The situation in 1924 gives a comparison between the health of the Army at home and in India as follows :

	Average strength	Ratio per 1,000 of strength.					Average sick time to each soldier (days).	Average duration of each case of sickness (days).
		Admissions	Deaths	Invalids. Sent home.	Invalids. Finally discharged	Constantly sick.		
At Home ...	101,698	362·8	2·00		13·49	21·12	7·73	21·32
India	58,614	658·0	4·27	15·00	14·74	31·7	11·97	18·18

The position in 1924 in India is analysed as follows :—

Average strength of British troops	58,614
Of which 65.8 per cent. were admitted to hospital	38,569
Of which two-thirds were communicable and infectious diseases	25,000
Of which three-fifths were caused by biting insects	15,167
Of which :	
Malaria (mosquitoes) represented	12,120
Dengue (mosquitoes) represented	1,005
Sandfly fever (sandflies) represented	2,042

" Diseases caused by biting insects are, therefore, the most important problem that military hygiene in India has to deal with, and the first and foremost of all is malaria."

Chapter II deals with malaria, a Kali straddling the round world, the destroyer of past civilizations, who to-day in India attacks 100,000,000 of the inhabitants each year, and slays one and a half to two million victims. During the last decade of the nineteenth century, the definite responsibility of the mosquito for the spread of this disease was established by Major Ross. During the last thirty years, the campaign against this enemy has been waged with increasing knowledge and varying success. It is during the last five years that in India results have been definitely more hopeful, and the author states that this is due to the following measures :—

(1) " Cold storage " of troops, *i.e.*, withdrawal of as many as possible from malarious stations to the hills during the infective season (August to October).

(2) Mosquito-proofing of barracks for the troops that must stay down during this period.

(3) Fumigation of barracks at the end of the cold weather.

(4) Propaganda and education.

(5) Measures of interior economy and discipline in units, *e.g.*, proper care and use of mosquito nets, use of repellents and so on.

(6) Drainage schemes, closing of wells, oiling, etc.

(7) Efficient artificial lighting of barracks.

(8) Effective treatment of malaria cases.

(9) Co-ordination of all measures in each malarious station under a specially appointed officer.

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Such places as Mian Mir (now Lahore Cantonment) and Amritsar are beginning to lose their evil reputations.

Further chapters deal with organization, research, and cantonments. The " cantonment " in India is a military phenomenon that is unique. Its history is interesting, but cannot be gone into in detail; sufficient to say that a situation has been allowed to grow up in which the tail wags the dog, and in the " cantonment " which was originally to serve the interests of the troops and provide living accommodation for the officers, vested interests have reached such proportions that the Government felt itself obliged to meet the " progressive spirit of the age " here as elsewhere in India, with results that the enforced resident in cantonments can only deplore. " The spirit of the reforms " has created in an Indian cantonment a machinery of administration that does not make the enforcement of sanitary conditions any easier.

In a summary the author states that the health of the British Troops in India is on a lower level than that of the troops at home, mainly owing to the prevalence of certain " tropical diseases " that are largely insect-borne, and can be prevented by suitable measures.

This is a book which all officers should read, and especially engineer officers, who serve so largely in India. The work of the military engineer there brings him into close touch with the medical fraternity, and by co-operation between the two professions much could in former days be done quietly to improve sanitary conditions for the soldier. The engineer incidentally provided a useful check on the sometimes over-enthusiastic schemes of his medical *confrère;* schemes which often changed their scope and character in a somewhat bewildering fashion with a change in M.O.

P.H.K.

FURTHER ASPECTS OF MECHANIZATION.

By BRIGADIER-GENERAL ROWAN-ROBINSON.

(Clowes, 6s.)

Brigadier-General Rowan-Robinson is not happy with the way things mechanized are moving. In his book, *Further Aspects of Mechanization*, he tells us about his misgivings, explains why he would recommend us to go "nap" with completely mechanized formations for our winning cards, and sketches out their design.

Brigadier-General Rowan-Robinson tells us what practical experience he has had of these matters, to which he has given much thought, and as a result he maintains that the tendency, which he discerns to-day towards " motorization," rather than towards " mechanization," will be to little purpose and will bring us in but a small return in comparison with the achievements that might be possible through further development of our recent Experimental Armoured Force.

In spite of all that has been said and done recently, the author contends " that success in the warfare of the future in average terrain in civilized countries lies in the purest form of mechanization." He is fully aware of the shortcomings of the medium tank as a machine on which an Armoured Force should be built, and he recommends in lieu the multiple-wheeled armoured car ; for reconnaissance work light scout cars are added ; no 18-pounders, a very few howitzers and something in

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the nature of a 3-pounder as the main artillery weapon. A battalion of four companies of light infantry to the proposed brigade, the necessary engineers and the closest co-operation with the R.A.F.—so close should this be that eventual incorporation of R.A.F. units in the force is envisaged as a logical outcome for control, co-ordination and the air-borne maintenance.

These are the lines on which Brigadier-General Rowan-Robinson would see matters moving.

So little is known as yet, however, about the multiple-wheeled armoured car that one is not sure whether prospects of development in this direction are in fact as bright as the author considers; if he is correct, then his proposals would be attractive.

As regards the author's criticism of the disbanding of the experimental armoured force, many may wish that the experiment could have been continued, but as we have always to be ready for war in any theatre with resources immediately available, we probably cannot afford to practise solely with independent armoured forces.

Motorization appears to be inevitable, and we are endeavouring to compete with it, together with all its attendant intricacies of maintenance, etc., etc. Mechanization, however, is a much more ticklish affair, and although we may not at the moment be able to test out formations any further in this respect, the author can rest assured that the subject continues to receive considerable attention!

Further Aspects of Mechanization is well worth reading for the views, admittedly personal "and often, maybe, heretical," which the author holds on many aspects of mechanization. As regards Sappers in particular, it is indeed heartening to read that the author considers them "the most efficient and up-to-date part of our mechanized forces," and the reviewer heartily concurs with Brigadier-General Rowan-Robinson's statement that "Certainly there is now no such live job in the soldier's world as that of the Mechanized Engineer."

N.T.F.

PIPE AND TUBE BENDING AND JOINTING.

By STANLEY P. MARKS.

(Isaac Pitman & Sons, Ltd., price 6s.)

This book, of some 150 pages, is written primarily for the artisan, and is, consequently, in comparatively simple language, is not encumbered with a host of technical terms, whilst the information given is generally of a high standard. It covers quite a large field, including lead, copper, aluminium, zinc, tin, iron and steel tubings, both as to the methods of bending and jointing. There is, however, one notable omission—the jointing of cast-iron pipe, both by molten lead and blue wool, not being touched on at all; and the subject of screwed iron and steel tube joints is dismissed in a very few words. The value of the book to an apprentice learning the trade of plumber would be greatly increased by a chapter, or at least some paragraphs, on pipe-screwing and the various machines used for this purpose.

The chapter on iron and steel tubes is excellent (in so far as it goes), and the notes extracted from the publications of the British Aluminium Company on the difficult question of Aluminium Welding and Soldering, and given in Chapter VIII, are of great value.

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The author also makes a rather doubtful remark on page 16, when he states in connection with sand loading for bending lead pipes, "it is a most convenient method for the amateur and novice, and for those who have no proper tools, as, for instance, colonial workers and army mechanics."

One hopes that he had in mind a Sapper in the Field, with a minimum of tools—otherwise it is feared that the general reader will gain a poor impression of the way in which Service workshops are equipped.

J.H.D.B.

THE UNIVERSE AROUND US.

SIR JAMES JEANS, M.A., D.SC., LL.D., F.R.S. (Camb. Univ. Press. 1929. Price 12s. 6d.)

Any attempt to review this book, in the sense of criticism, would be both foolish and impertinent. It is written by a master, and, unlike most such works, is comprehensible by any student of ordinary intelligence. More than that, it provides delightful reading for those who read rather for amusement than for study. For rigorous scientific argument and mathematical analysis, reference can be made to an earlier work of Dr. Jeans, *Astronomy and Cosmogony*, published in 1928. Those whose mathematical equipment is inadequate to deal with stellar dynamics and modern cosmical physics will find in the present volume a fascinating and up-to-date account of their achievements in astronomy. The clarity with which Dr. Jeans explains the most difficult problems is indeed remarkable; we take Einstein, so to speak, in our stride; and even the Quantum theory assumes an air of relative simplicity while we read. A book, in short, that can be warmly recommended to every R.E. officer, and that few, having once finished, will not want immediately to begin all over again.

G.H.A.

SURVEYING.

For Agricultural Students, Land Agents and Farmers.

By A. H. HAINES.

(Longmans, Green & Co., 12s. 6d.)

As its title implies, this book is primarily designed to give practical help to agricultural students and the like who are called upon to perform various tasks in which Survey is all-important.

For the most part, therefore, it deals with all the aspects of Surveying with the chain, but there are also chapters on the Theodolite, Plane Table, etc. It is rather abridged in places, but as the author states in his preface, this was part of his object, as most of the textbooks on Survey are too voluminous for the particular public for whom he has written this book.

The first chapter is a masterpiece on Mensuration, and tells you all there is to know on this subject, from "How to ascertain the weight of cattle" to "How to measure felled timber," besides a host of other interesting tables on weights and measures.

The next two chapters are devoted to Chain Survey. The methods of booking, etc., are different to those taught to the Young Officer on his Survey Course at Chatham. The diagram on page 33 and the specimen

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Field Book on page 34 would have been much better if they had not been so cramped, and if they had been on the same page for ease in comparison. The Line Nos. on Fig. 17 are very poor.

Long chapters are devoted to Scales, Plotting and Plan Drawing, followed by specific descriptions of various survey instruments. There is nothing in this book which is not in the Surveyor's " bible," the *Textbook of Topographical Surveying*, except chain survey and a description of one or two instruments like the box sextant, etc., and these are dealt with by pamphlets compiled and issued by the Survey School at Chatham. For those for whom it was written it is doubtless an excellent book, but for the Sapper officer it cannot do more than supplement his existing books or pamphlets on the subject.

R.E.F.

MECHANICAL ENGINEERING.

By LIEUT.-COLONEL W. A. MITCHELL, U.S. Army.

(Chapman & Hall, 20s.)

The author, in his preface to this excellent little book, says:

" This textbook is prepared especially for the cadets of the United States Military Academy, who are being fitted for duty in the United States Army . . . Every Army officer must have a fair working knowledge of the principles and practice of mechanical engineering: he applies this in his work on army posts in time of peace, and with motor vehicles and shop machinery in time of war. In this book the cadet is taught enough of the branches of mechanical engineering, so that he may in future understand the practical mechanical engineering requirements of his profession."

Although this book, then, is written for every U.S. army officer, Sapper officers need have no fear that it is too elementary for them to read, for its contents are approximately what is taught about mechanical engineering to all young Sapper officers at the S.M.E., Chatham, and at Cambridge, with the notable exception of metal workshop materials and practice. We may deduce, however, that the mechanical education of officers generally has made more progress in the U.S. army than in our own. Whether or no all officers of a modern first-class army should know all that the book contains is open to debate, but it is certain he must know some of it. This is where this book is so good, for it may almost be said that it is readable by the general public: certainly by people educated as well as the average British infantry officer.

The headings of the chapters include: Thermodynamics, Fuels and Combustion, Steam Power, Gas Power, Water Power, Power Transmission, Electrical Power Systems, Compressed Air, Lubricants, Refrigeration, Heating and Ventilation.

The text is extremely well written and illustrated. Points that stand out in the editing are that paragraphs are numbered throughout and the illustrations are numbered to correspond with the appropriate paragraphs.

The book does not attempt to give practical information about the running and care of engines, etc., it simply tells how they work and what their ordinary applications are. In respect of application, mention must

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be made of many extremely well-worked examples included in the texts and lists of problems at the ends of some of the chapters, all very practical and in connection with the employment of mechanical power, etc.

The omission of metal workshops' materials and practice is a pity. These subjects are part and parcel of mechanical engineering.

The book contains a few inaccuracies and somewhat bold statements which should not occur in a textbook of this type. For instance, we find the very high speed of a small de Lavel turbine twice given as 3,000 r.p.m. Under "Boiler Tests" we find "A simple safety test may be made by simply pumping water into a boiler until the desired testing pressure is obtained. If there are no leaks the boiler is considered safe." Or again, "The only commercially successful turbine of the reaction type, the Parsons turbine . . ."

T.C.W.B.

WIRELESS TIME SIGNALS FOR THE USE OF SURVEYORS. Third Edition, by ARTHUR R. HINKS, C.B.E., M.A., F.R.S. (Published by the Royal Geographical Society, 3s.)

This new edition of Mr. Hinks' pamphlet on Time Signals can briefly be described as being quite as indispensable to any surveyor as his book of logarithms or his penknife. There is no other book which collects in this way all information as to existing time signal services. In addition to the ordinary explanations of their various forms, it gives a large number of essentially practical details which can only have been learnt by extensive listening-in to all the signals. Few for instance can have realized that there is a considerable difference as regards the precision with which the preliminary calls are sent from Bordeaux and from Nauen, or that the Rugby signal was imperfect no less than eight times in five months in 1928.

Any surveyor who has used wireless time signals has always in the past suffered from not knowing in what publication to look for details as to errors in transmission. Vaguely he has realized that the Bureau Internationale de L'heure issue some kind of error list for French stations, but where to get this publication has usually defeated him. He cannot buy it on a bookstall. Mr. Hinks has given the most useful practical help in stating the name and address of the agent for this publication, as also for the correction list published by the Admiralty. This latter list deals solely with Rugby, Annapolis, Bordeaux and Nauen, and the arrangement by which the Astronomer Royal undertook to record the errors of these four time signal stations only came into force in 1928, so that to most surveyors it will be news that such a valuable and easily procured list of corrections exists.

A summary of the first four months' results since this checking of time signals was undertaken by the Royal Observatory is given on page 6 of the pamphlet, and is most interesting. It is also flattering to our national station, Rugby, which quite easily leads the field for accuracy.

Page 14 has some interesting experiences as to call signs recorded. One cannot quite imagine the feelings of a surveyor or explorer returning to his base after many months, when he is told that he need not have rejected the signals beginning with the call sign FYL as being from some unknown station. Mr. Hinks records that the great Bordeaux trans-

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mitting station, so well known and so popular with all who have practical experience of longitude determination by W/T time signals, solemnly changed its call sign from the familiar LY to FYL without any sort of warning or even prompt official notification.

On the subject of the reception of time signals other than by chronograph, the pamphlet wisely remarks that every observer has a method of his own which he considers better than any other. Cynical but true. It seems, however, a pity to dismiss all chronograph recording as being too elaborate for field use. Automatic recording surely is, but many surveyors would prefer a chronograph and press button to any system of coincidence judging. Taking the mean of fifty standard rhythmic dots by chronograph has, in fact, proved itself to be a very suitable field method, and the use of the same press button and chronograph for booking the star over the cross wires of the theodolite introduces that accord of method which Mr. Hinks emphasizes in his description of coincidence judging when the chronometer has no microphone.

The second part of the pamphlet is taken up by an immensely useful schedule of all suitable time signals, arranged in order of the time at which they are sent instead of by countries or alphabetically. This is a far more helpful arrangement than that adopted in the Admiralty List of Wireless Signals to which most surveyors are wont to refer.

Each signal is set out in diagrammatic form, and in addition the wave length and type of transmission is stated. Useful notes as to reliability and vagaries are also given.

Finally, there is a map showing the true bearing of Rugby from all parts of the world, which will save many a wearisome computation to those surveyors who are using that station for their longitude work.

Indeed, one cannot but repeat that Mr. Hinks' book is a piece of equipment which it would be quite stupid to leave behind when starting out upon a surveying expedition.

P.K.B.

CIVIL ENGINEERING: A TEXTBOOK FOR A SHORT COURSE.

By Lieut.-Colonel W. A. Mitchell, U.S. Army.

(Chapman & Hall, Ltd., 30s.)

There is a mass of heterogeneous information contained in the 700 pages of this book, covering an extremely wide range, and varying from broad panoramic views to minute examination of detail. It is undoubtedly an ambitious task to condense into one volume a textbook of all the various branches of civil engineering, any one of which is justly entitled to treatment on a scale equivalent to that devoted to the whole.

In order to appreciate the success of this monumental effort, it is essential to ask oneself the question—"For whom is the book intended?" That is, what class of the community is so situated as to require in its daily work, not only the broad outlines of knowledge conveyed by this work, but also the elaborated and incomplete details with which it is embellished?

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The solution to these questions is apparently contained in the following passage of the preface :—

"Every army officer must have a fair working knowledge of the principle and practice of engineering ; therefore, in this book the cadet is taught enough of all branches of civil engineering, so that he may in future understand the practical engineering requirements of his profession. For the engineering work of the army requiring great technical knowledge, this textbook is supplemented by additional courses given in army schools to officers of the engineering branches of the army."

This passage raises points of such interest and is of such basic importance in appreciating the value of the book, that a detailed examination is essential. From this, three questions immediately emerge :—

(*a*) Is it essential for "*every* army officer to have a fair working knowledge of the principles and practice of engineering?"

(*b*) Does a textbook on civil, as opposed to military, engineering supply his need ?

(*c*) Does this textbook "teach enough of all branches of civil engineering, so that he may in future understand the practical engineering requirements of his profession ? "

To consider this seriatim :

Query (*a*) : The answer to this is admittedly a domestic matter, upon which our opinion would be superfluous to the West Point instructional staff. To our minds, it would appear that an infantry officer can be equally, if not more, efficient at his job if he is not an expert in, say, city planning, reinforced concrete design or sewage disposal methods.

Economy of force and concentration of effort are principles of life and not only of war, and an officer cannot concentrate on his own particular job if he is dispersing his efforts over such a vast field of enterprise.

The crucial point of the statement is admittedly the definition of what constitutes a "fair working knowledge," and this we can only infer from the problems in the book, which the reader is expected to solve.

It is not unjustifiable to state that, on this side of the Atlantic, the vast majority of these problems, although undoubtedly within the capacity of all officers, are yet equally undoubtedly within the specialized domains of the technical corps.

Query (*b*) : In appreciating this point, the nature of the subjects dealt with under the heading of civil engineering should be realized, and for this it is only fair to be guided by the contents of the book under review. It is divided into four parts :—

Part I : "Mechanics of Engineering"—Forces, Tension, Compression, Shearing, Torsion, Flexure ; Beams ; Moving loads ; Pressure and Flow of Water.

Part II : "Building Materials"—Timber ; Metals ; Natural and Artificial Stone ; Testing of Materials.

Part III : "Component Parts of Structures"—Framing ; Masonry ; Columns ; Foundations ; Metal Work.

Part IV : "Engineering Structures"—Buildings ; Bridges ; Dams and Retaining Walls ; Water Supply ; Sewerage and Sewage

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Disposal; Railways; Highways; City Engineering; Construction Equipment; Specifications.

With such a comprehensive list of subjects and only 700 pages in which to deal with them, the marvel is that the author has been as successful as he has!

But to return to our query; an officer envisages two phases of his professional career—Peace and War.

In peace time, he has at his disposal the full resources of the civil and military engineering professions, and a knowledge of their work, although of interest, is no more essential to him than to any other citizen.

In war, he is faced with a full-time job of his own and, although a knowledge of the elements of field or military engineering is a necessity, few, if any, of the headings and sub-headings enumerated above will be of the slightest assistance to him in the execution of this job.

Query (*c*): The severest criticism of the book must inevitably be contained in the answer to this question. It is the old, old story of falling between two stools.

Unnecessarily precise for a cursory survey, it is at the same time insufficiently detailed for use as a technical textbook.

The layman would never face the calculations (including differential and integral calculus) presented to him. Why should he? What does he stand to gain if he does?

The engineer could carry through no work of any magnitude without additional recourse to a textbook devoted entirely, or, at any rate, in very much greater detail, to the operation in which he is involved.

In general, the author appears to presuppose an interest and a degree of mathematical knowledge which is unlikely in a layman, while the information imparted by him is of little value to the engineer who finds himself faced with a definite problem, in the solution of which he turns to a textbook for assistance.

It is a matter for regret that no answers are appended to the problems set at the end of each chapter. These are of a distinctly practical nature and would tend, with the suggested addition, to arouse more than anything else that interest which is so essential.

A.D.C.

(*a*) CANTERBURY AND ROCHESTER, WITH MINSTER IN SHEPPEY.

(*b*) GLOUCESTER AND WORCESTER, WITH TEWKESBURY, DEERHURST AND MALVERN.

(*c*) WELLS AND BRISTOL, WITH BATH, GLASTONBURY, MALMESBURY, ST. MARY, REDCLIFFE and BRADFORD-ON-AVON.

(Bell's Pocket Guides, Cathedral Towns and Neighbouring Churches, 2s. each.)

This new issue of small guides replaces Bell's well-known Cathedral series, which is largely out of print. The plan of this series is plain from the titles, two Cathedrals and neighbouring churches of interest being dealt with in each volume.

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The architecture is clearly and interestingly described in each case, and the points of interest in the cathedral towns are also dealt with.

The books are well illustrated from photos, and as far as can be seen from the guide to Canterbury and Rochester, are as up-to-date as is possible. The activities of the Friends of Canterbury Cathedral in restoring the Water Tower, however, are not recorded, but the restoration of the wall-painting of the legend of St. Eustace finds a place.

This is a valuable series, and cheap for the price charged.

P.H.K.

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1929.)—Lt.-Col. Grasset completes "*Montdidier, le 8 août, à la 42e division*," in this number. The final action of this day was the capture of Fresnoy-en-Chaussée by this division, helped by two battalions of the 1st Regiment of Moroccan Rifles. The attack was to take place with the help of French tanks, but, owing to the short time available, some of the troops advanced before the tanks and an excessive muddle of units ensued. However, the village was captured, and completed a wonderful day's work for the 42nd Division. Général Débeney's order after the attack reads :—

> "The 42nd Division has just opened the gates of victory. The 3rd Army is now about to attack. If the battle assumes an unexpected success, it is due to the rapid thrust of the 42nd Division."

Lieut.-Col. Grasset concludes with an appreciation of the splendid work done by the Moroccan battalions, who well deserved to share in the praise given to the 42nd Division.

Lieut.-Col. Vanthier continues "*La défense anti-aérienne des grandes unités*," in this number. He discusses articles written in the *Journal of the Royal Artillery*, by Capt. Loch and Major Cherry. Both writers agree that ground artillery cannot undertake anti-aircraft fire, unless they are back, out of action, and then they can only act as a support to the true anti-aircraft artillery. Lieut.-Col. Vanthier agrees with these conclusions, and also arrives at the following points :—

(*a*) All small arms, including infantry guns and machine-guns, must be designed so as to be able to attack low-flying aircraft and tanks.

(*b*) Every commander must be responsible for his own air defence, and so must have the necessary weapons, apart from general air defence provided from above.

In the second and final instalment of "*La VIIe armée allemande en converture en août, 1914*," Capitaine Marchal describes the successful attack of this army. The French 7th Corps was extended on a wide front, facing N.E. and S.E., when the German Army commander decided

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to strike. After actions at Cernay and Mulhouse the French were driven back, but General von Heeringen, the 7th Army Commander, failed to maintain his grip on the operations, which were not as successful as they might have been. However, the German 7th Army fulfilled its task as a covering force completely.

Général Armengaud and Commandant Donnio complete "*La pacification de l'Afrique encore insoumise*," in this number. It is suggested that now is the time to pacify the remaining stretches of N.E. Africa, where the tribes have still failed to come to hand, using a small but practically invulnerable force, viz., aircraft and a specially composed land force. There is little doubt that aircraft can effect a great deal in an area where water is infrequent and the tribes are drawn to the oases, and quite a small land force, if properly organized, can complete the work. The article is illustrated with some quite good air photographs of the area and two sketches.

In completing "*La genèse de Neufchâteau*," Commandant Pugens describes the difficult situation of the German Fourth Army. Owing to bad weather and the wooded country, the Duke Albrecht, commanding the Fourth Army, had practically no knowledge of the movements of the French. The German Crown Prince, on his left, then decided to attack, against the wishes of Moltke, thereby exposing his right flank. A German staff officer from the right corps of the Fifth Army came to Duke Albrecht's headquarters in the middle of the night, to ask for the left corps of the Fourth Army to cover the attack of the Fifth Army. Duke Albrecht finally agreed, in spite of his ignorance of the situation on his front, and this brings us to the eve of the battle of Neufchâteau, on the Fourth Army front.

(*August*, 1929.)—Lieut.-Col. Desmazes begins an interesting series of articles, entitled "*De Liao-Yang à Moukden*," in this number. The writing is free from details of units, at least in this instalment, and he describes clearly the situation at the outbreak of the Russo-Japanese War, and also shows how Japan lost her numerical superiority by the autumn of 1904. It is pointed out that Kuropatkin, in 1903, recommended that Russia should relinquish her hold on Port Arthur and give up any idea of occupying Korea, and it may be that the rejection of this advice in Russia led to the general defensive policy of Kuropatkin, when he was appointed as Commander-in-Chief. A very interesting point made is the Russian mania for producing "combined formations," in which units were detached from their proper formations and banded together without staffs. This custom had naturally a great deal to do with the general failure of the Russians.

In completing "*La défense anti-aérienne des grandes unités*," Lieut.-Col. Vauthier gives mainly a technical discussion still based largely on writings by Major Cherry and Capt. Loch, of our own R.A. He arrives, however, at a suggestion for air protection by light artillery and infantry guns, namely, that they should be designed so that they can take on the three tasks of fire against tanks, aircraft and field objectives. One must agree that the normal anti-aircraft artillery cannot provide full protection, and although further training will be necessary, it does seem that Lieut.-Col. Vauthier's solution will probably be the correct one.

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Yet another article, entitled "*Les mémoires de Napoléon*," by Général Camon, appears in this number. It is of little interest to anyone who is not actually studying Napoleon's writings, being concerned largely with the differences between his memoirs dictated to Les Cases and to Montholon at St. Helena.

"*Les confins sahariens de l'A.O.F. en* 1929," by Commandant Cornet, describes the methods adopted by pillaging bands in Northern Africa. Especially on account of areas belonging to Spain into which these bands can escape, the French find it still very difficult to "discourage" these robbers. The appearance, however, of mechanized vehicles, wireless telegraphy and aviation, have proved an enormous help, and it is to be hoped that in time the French will be able to produce real peace in this somewhat turbulent area.

Lieut.-Col. Aublet begins "*L'artillerie française de* 1914 *à* 1918," in this number. The first section deals with the actual material and is not of particular interest. In the second section, we recognize the same problems in the method of command of the artillery as were faced by ourselves. In this number, the writer explains how fresh commanders were provided to deal with the growing mass of artillery as the War proceeded.

(*September*, 1929.)—The second instalment of Lieut.-Col. Desmazes' "*De Liao-Yang à Moukden*," describes the battle of Liao-Yang, together with the events leading up to it. It is quite clear that Kuropatkin held the advantage more than once, but could not nerve himself to launch the necessary counter-attacks with a big reserve. As it was, the reserves were used piecemeal. A typical instance of command by the Russians before the battle is given. General Sassulitch said, "His Majesty has awarded me the order of Chevalier de Saint-Georges. A Chevalier de Saint-Georges never retires." Unfortunately, he followed this remark by a very brisk retirement, although he was commanding the Russian covering force at the time, and asked if he might go back to Liao-Yang. It is not surprising that the Japanese were always successful when opposed by commanders of this type.

Général Chédeville begins "*Motorisation des engins de combat rapproché*," in this number. He points out how, through the ages, efforts have been made to bring the fighting man up to close contact with his adversary, by the use of shields, armour, and the like. Since the appearance of petrol as a motive power, this has developed into the production of tanks. In this instalment the writer considers the various limiting factors for the present-day tank and gives his opinions regarding its design. The different arguments are familiar to any student of mechanization.

"*La prise de Neuville Saint-Vaast*," by Commandant Lefranc, describes the French attack of May, 1915, which was designed to break through into the open country. Actually, it took a month of fighting to capture this village, in spite of the enormous amount of infantry and artillery collected by the French. The result of the operations was a reconsideration by the higher command of both the Allies and the Germans, as it became clear that an attack on a narrow front had little chance of success. Général Foch was commanding the northern group

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of armies with Général D'Urbal, a real fighting army commander, directing the attack, but in spite of the gallant efforts of the French, the result was comparatively insignificant.

Lieut.-Col. Aublet completes "*L'artillerie française de 1914 à 1918*," with a description of the different tactics employed throughout the War. At the outset, the French artillery failed to support the infantry. This was quickly remedied, but the development of defensive positions produced the necessity for destruction by the artillery. The method of this period definitely failed, partly owing to the enormous expenditure of ammunition, and so surprise was attempted, combined with neutralization, instead of destruction. We all know how successful this last method was, but as the writer points out, it will be by watching developments in a future war, not by sticking to existing successful methods, that success will again be attained.

A short article, entitled "*La guerre en haute montagne*," by Capitaine Tourret, describes the conflict between the Italians and the Austrians in two sections of the mountain front. Clearly, little was gained on either side, in spite of casualties which varied from a small to a large percentage of those employed. Capitaine Tourret points out, however, that mountains cannot be neglected in a long war. The Italians have, all the same, practically given up their wire railways, by which supplies were mainly delivered, which makes us wonder whether they have already forgotten the lessons of the Great War.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

(*May*, 1929.)—In an article, entitled "The Engineers of the 133rd Division in Belgium," a description is given of a pile bridge for heavy loads, constructed over the Yser Canal in August 1917, by two companies of Engineers. The bridge has seven piers, each of five piles.

In "The Engineers in Cochin China," Lieut. Botrel gives an account of work carried out in the shape of river crossings by native companies of engineers who, for the first time, took part in manœuvres. Owing to their breadth and frequency, the waterways can only be crossed by means of rafts.

There is a translation of Lieut. L. T. Grove's article in the March number of the *R.E. Journal*, called "The Use of Power Tools in a Field Company R.E."

(*June*, 1929.)—"A Story of Mine Warfare," by Col. Bailles, is an account of the mining carried out on the 28th Divisional front in the Proyart region of the Somme. In October, 1914, the General commanding the Division conceived the idea of attacking the village of Dompierre, by means of sapping and mining. The Lieutenant commanding the 14/2 Company of Engineers, pointed out that the distance of the village—about 300 metres—and the absence of all mining material would make the operation a very lengthy one, in which opinion he was supported by the Chief Engineer of the Corps. Nevertheless, the General persisted, and towards the end of October, mining was started by two companies. A detailed account is given of the operations and the varying fortunes of the combatants on either side - for the Germans

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naturally started mining as well. Mine warfare gradually extended along the whole divisional front; it lasted for ten months, but the results were such as to justify the belief that the sappers would have been better employed in their normal manner.

There is a short article on the narrow-gauge railways in Morocco, by Lt.-Col. Suchet, and an account of a semi-rigid suspension bridge over the Rance, between Port St. Jean and Port St. Hubert, by M. Lebrun. The span is 173·65 metres between the piers. The two steel cables are eight-fold. The attachment of the vertical ties is to the upper part of the main girders (*poutres de rive*), an innovation whereby secondary stresses are to a great extent eliminated. The supporting joists for the roadway, which consists of a ferro-concrete slab, 12 cm. thick, are of I pattern, 400 mm. deep. The roadway and the main girders together form a channel ⊔ capable of resisting the most violent wind-pressure.

(*July*, 1929.)—Captain of Cavalry Gazin contributes a long article on the use of narrow-gauge railways in the war of movement in France and Germany, with special reference to the advance of the 1st Army, in 1918.

Lieut. Botel, in "The Use of Habert Bags," describes how, by means of a framework, these waterproof bags can be joined together to form rafts of various sizes. A raft made of five bags can carry twenty fully-equipped men, whereas a single bag can only carry three.

A.H.B.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1929. TOME II.—NOS. 1 TO 3 INCLUSIVE.)

"*Les opérations de l'Armée belge*, 1914–1918." An account is given of the events of a part of the period during which the Belgian Army held the section of the line Nieuport Canal–Furnes–Steenstraat. The portion of it appearing in No. 1, deals with the events which took place between March 11th and April 22nd, 1915. The general situation at the beginning of March, 1915, is briefly reviewed. In the middle of December, 1914, after the Battle of Lodz, the Eastern Front had become stabilized; however, the enrolment of the 1914 class of recruits enabled the Germans to create four new corps (XXXVIII to XLI) and a new Bavarian Division. Three of the new divisions were sent to the Western Front, and nine of them to the Eastern Front; at the end of January, 1915, the German XXI Corps was also transferred from the French to the Russian Front. At the beginning of February, 1915, the Germans resumed offensive operations in E. Prussia, and severely defeated the Russians in the region of the Masurian Marshes. However, in spite of the disaster which had overtaken their forces, the Russians soon returned to the attack; the Battle of Prasnyz (February 22nd to 27th) took place, and the enemy's advance was definitely checked. About the same time, the Germans had resumed active operations in the Carpathians; they succeeded in re-occupying the Bukovina.

In view of the fact that the Germans were now concentrating all their efforts for the purpose of bringing about the complete overthrow of the

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Russian armies, Joffre hoped to take advantage of the numerical superiority of the Anglo-French armies and proceeded to make arrangements for an offensive on a big scale on the Western Front, with a view to holding a maximum of enemy troops in Belgium and France: for this purpose, the operations of the French 4th Army in Champagne were continued, and a new attack was to be launched in Artois by the French 10th Army. Owing to Sir J. French's inability to take over the section of the front in the Ypres Salient held by French troops, the proposed stroke in Artois had to be abandoned. The B.E.F., however, attacked to the N. of La Bassée on March 10th, and succeeded in capturing Neuve Chapelle; heavy losses and shortage of ammunition led to these operations being abandoned four days later.

It was now felt that the chances of success in the Champagne were small; in consequence, the operations of the French 4th Army also came to an end.

On February 27th, whilst plans for the proposed offensive of the French 10th Army were being worked out, Joffre enquired whether the Belgian High Command could take over a part of the line in the neighbourhood of Steenstraat, held by the French 8th Army. The proposal having been agreed to, subject to the French becoming responsible for the defence of the Nieuport Sector, the Belgian 6th Division relieved the French troops near Steenstraat, on the night of March 10th-11th; the French took over the Nieuport Sector on the evening of April 22nd. The measures taken in effecting the reliefs mentioned above are described in some detail in No. 1; the evolution in tactics during the early days of the stabilization period are also discussed.

The actions fought in the neighbourhood of Steenstraat, between April 22nd and May 25th, are dealt with in No. 2; they form a part of the operations known officially as the Battle of Ypres, 1915. The main object of the German attack in this locality was to try out the value of chemical warfare in the field, and to test the efficacy of the poison gas with which German chemists had been experimenting in their laboratories.

A brief review of these operations is given. On the evening of April 22nd, the French, holding the section of the line between Steenstraat and Poelcappelle, were completely taken by surprise and, large numbers of them having been put out of action by the poisonous fumes, had to fall back; in consequence, the Germans were able to cross the Yser Canal at Steenstraat and Het Sas. The Canadian and other British divisions lent timely support and by dawn on the morning of April 23rd, the breach in the Allied line was partially closed. French and British reinforcements were poured into this area. In the meantime, the enemy continued his offensive and succeeded in penetrating deeper and deeper into the Ypres Salient. The part played by the Belgians during the period of these operations is dealt with. Sketch maps indicating the position of affairs at various dates are provided.

The events of the period May–December, 1915, are dealt with in No. 3. The military situation in Europe during the period in question is briefly described. The Germans were now determined to annihilate, if possible, the Czar's armies. For this purpose, a new and powerful German army was constituted and placed under von Mackensen, who advanced on

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Cracow on May 2nd; at the same time, a general offensive of the Austro-German forces on the Eastern Front was launched. The Russians were compelled to retreat and abandoned Galicia, Poland, Lithuania and Courland; they succeeded, eventually, in stemming the advance of the invaders, on a front extending from the Gulf of Riga to the Bukovina District. Trench warfare now began on the Russian Front and lasted until January, 1916.

The Germans having assumed a defensive attitude on the Western Front, owing to the depletion of their forces, the French High Command launched a series of attacks against the Germans in Artois and Champagne. In the meantime, on May 23rd, Italy joined the Entente Powers as a belligerent. Although the French attacks did not produce any decisive results, these operations and the Italian menace lessened to some extent the enemy's pressure on the Eastern Front, and proved of assistance to the Russians. On the other hand, the intervention of Bulgaria, as a belligerent on the side of the Central Powers, on October 5th, resulted in Serbia being completely crushed before the end of 1915. It is further pointed out that the Gallipoli Campaign (April 25th, 1915—January 8th, 1918), and the occupation of Salonica in October, 1915, created a drain on the forces of the Entente; the value of these diversions cannot be assessed with certainty.

"*La tactique des renseignements.*" The first three parts of an article under this title, by Colonel Tasnier, of the Belgian General Staff, appear successively in the numbers of the *Bulletin* under notice; they deal with the intelligence service. General principles are dealt with and discussed under various heads in Part I. The several sources from which intelligence is obtained are briefly reviewed: the "organs of discovery" are touched upon; the successive stages by which intelligence is collected and distributed are stated; the specific purposes for which intelligence may, on particular occasions, be required, are discussed and the importance of planning suitable schemes for the collection of intelligence is emphasized; matters connected with the recording of information, its distribution, analysis and utilization, are each separately treated.

Part II deals with the work of the intelligence department; the organization and functions of the *2e bureau* of a Belgian Army Corps are examined in some detail; the methods employed in obtaining intelligence and in transmitting it to the proper quarter are described at some length.

Part III is devoted to matters connected with the centralization of the intelligence services and the analysis of information. Tables are given which set out in summarized form the important points in relation to which information should be obtained, and the particulars that should be recorded.

"*La survie d'un peuple.*" Three parts of an article under this title, by Major F. Delvaux, appear successively in the numbers of the *Bulletin* under notice; the article deals with the military history of Serbia. In a short introduction, Major Delvaux points out that the histories of Belgium and of Serbia indicate that there are many resemblances in the experiences through which their peoples have passed in times gone by; in both these small territories, the inhabitants have, from time to time, had to submit to the temporary domination of a foreign overlord,

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and have, in consequence, been subjected to oppression and the loss of their liberty.

In Part I, the migration of the Slav tribes from Russia to the banks of the Vistula and the Danube, in the fifth century of our era, is traced; the territory occupied by the Serbs in the seventh century and its military features are briefly described; the anarchy which reigned in the Balkans and the Islamic domination in that region during the fourteenth century, are commented upon. The history of the Serbs shows that a traditional enmity has existed for centuries between them and the Turks and Austrians. After having been raised to the status of an important Power by Stéphane Douchan (1331–1355), a "Great Serbia" was laid low by the defeat of her army on the plains of Kossovo (1389); the national existence of the Serbs then suffered an eclipse which lasted for five centuries. A brief account is given of the Turkish invasion of Bulgaria in 1393, of the occupation of Constantinople by the Turks in 1453, and the effects of Turkish domination in former times on Yugo-Slavia.

In Part II, the gradual restoration of Serbia as a Power is briefly touched upon. Advantage was taken by the Serbs of the French Revolution, and the Islamic Civil War, to revolt against Turkish rule; they were organized and led by Karageorge (a breeder of pigs, who was formerly an Austrian N.C.O.), and seized Belgrade. Russia, being at war with Turkey (1806–1812), at first supported the Serbs, but left them to their own resources, when Kutusoff's army was withdrawn from Turkey to oppose Napoleon's advance on Moscow; the Serbs then took refuge in Austria.

The diplomats who assembled at the Congress of Vienna, in 1815, decided that the Yugo-Slav provinces should be incorporated in the Austro-Hungarian Empire, but they came to no definite conclusion regarding Serbia. An account is given of the manner in which Serbia regained her position as an independent Power, under the rulership of Miloch Obrenovich, a rival of the Karageorges, and of the conflicts between Turkey and Russia, during the latter half of the nineteenth century; Serbia was drawn into the vortex, but was rescued from her difficult position by the intervention of the Great Powers. Finally, by the Treaty of San Stefano (1878), Serbia was granted complete independence and an increase of territory.

The events leading up to the Balkan War (1912–1913) are briefly traced; an outline is given of this campaign, and of the Battle of Kumanovo (October 23rd–24th, 1912), and the Battle of Monastir (November 13th–17th, 1912), which resulted in the destruction of the Turkish Army of Macedonia by the Armies of the Balkan Allies. The Serbian Army played a prominent part in both these battles; in the latter, it took more than 10,000 Turks prisoners and captured 50 guns. The defeat of Kossovo was revenged by the victory of Kumanovo. An armistice was concluded on December 3rd, but as Turkey would not accept the peace terms offered by the Balkan Powers, hostilities were resumed. The Turks met with one reverse after another. The Great Powers, disturbed by the Balkan situation, arranged a Conference of Ambassadors in the spring of 1913; the belligerents were induced to sign the "Preliminaries of London," and hostilities were brought to an

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end. The Turks were now virtually expelled from Europe; they were allowed, however, to retain their hold on Constantinople and the Straits.

The ambitions of Austria being thwarted and her *amour-propre* wounded, she concentrated an army of 20,000 men on the Save and Drave, and put forward claims for the extension of the Albanian frontiers; to these, Serbia manifestly could not agree. The outbreak of hostilities on a vast scale became imminent during March–April, 1913; it was probably alone due to the fact that Germany's preparations for the Great War were incomplete at that date that the delivery of Austria's ultimatum to Serbia was postponed. An interesting review of the political situation in Europe, as it affected the Balkan Powers at this time, concludes Part II of the article.

Part III deals with the events connected with the Great War. The situation immediately preceding the outbreak of hostilities in August, 1914, and the Austrian plan of campaign against Serbia are briefly discussed. Accounts are also given of the Battle of the Tser (August, 16th–19th, 1914), and of the third Austrian offensive, during which the Serbs gained a victory on the banks of the Koloubara (December 2nd–15th), when they took 40,000 prisoners and captured 130 guns, together with vast quantities of stores. The Serbs look upon the results of the Battle of the Koloubara as being, in their theatre, similar in its effect on the war as the Battle of the Marne is recognized to have been in the Western theatre. However, the Serbian victory, Major Delvaux suggests, was more complete than the Anglo-French one; it brought about a complete liberation for a time of the invaded territory; the Austrians were pushed back to the strategic base from which they had opened the campaign.

W.A.J.O'M.

AN t-OGLACH.

The Journal of Cumman Costanta Naisiunta (The National Defence Association) of the Irish Free State.

VOL. II, NO. 3.

In the *R.E. Journal* of December, 1928, appeared a short review of *An t-Oglach*, together with remarks on the genesis of the journal. The number now under review is of interest, since it contains the constitution of the new National Defence Association, and defines the object of the Association: the means whereby it hopes to attain its object, the nature of membership, committee, etc., and states that this Association, through its executive committee, shall be responsible for the management of *An t-Oglach*.

In consequence, *An t-Oglach* takes its place alongside publications such as the *Journal of the R.U.S.I.*, as a semi-official publication, controlled by a Military Association.

Bearing in mind the individualistic attitude of the Irish Free State, and the fact that the Free State Army is outside the framework of the armed forces of the Crown, any information as to its military development must be of considerable professional interest.

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The Free State Army is undergoing a fresh reduction and reorganization. The effect of that reorganization is to bring the permanent forces in line with the permanent forces in the Dominions, in that the serving personnel exist to staff and train the, as yet, in Ireland, non-existent, active volunteer or militia forces.

Maj.-Gen. Hugh MacNeill, speaking at the Curragh, to an assembly of officers of the Reserve, in August, said: "Ireland has now ceased to attempt to maintain a standing army as such . . . The old army, as we knew it, is dead." It will be extremely interesting to see what arises in its place.

The influence of this period of transition is apparent in the other articles.

The editorial welcomes thirteen cadets, appointed to commissions as 2nd-lieuts., and cheers the incoming enthusiast with the statement that their arrival "has further aggravated the position with regard to promotion. We have now the extraordinary position that 2nd.-lieuts. with from seven to twelve years' service are serving in the same units with officers just commissioned."

So there is somebody worse off than the gunners.

Capt. D. J. Lawlor, of the Q.M.G.'s Branch, ends a well-reasoned article on the cavalry arm, and would like to see some cavalry in the army.

Maj. Cotter, General Staff, desires to "Abolish the Infantry." His arguments are conclusive and interesting. The possible enemies of Ireland, if propinquity makes enemies, are France and England. If the coast defence system, which he would substitute for the more usual army, fails, then the infantry will not be much use after the enemy lands. So why have infantry? The possible ally of Ireland in a world war is England. But England has always, according to Maj. Cotter, exploited the Irish infantry—she will probably do so again. Then why have any Irish infantry for her to exploit? There is something to be said for this argument; if it is agreed that committing suicide before the enemy arrives is the least painful solution of a military problem. Maj. Cotter's views are throughout original, witness his statement that: "It is not pleasant for any officer to send men to their death but, once faced with the necessity, human considerations will direct the sending of the stranger in preference to one's own." This method is no longer approved since the system of "Fighting to the last Russian," failed in the late War, because the last Russian wouldn't fight. Maj. Cotter is, one feels, in the running for the Nobel Peace Prize.

Col. O'Connell has a well-written and interesting article about the "Manœuvre of Bantry Bay," which it is to be hoped the Association will publish in pamphlet or book form.

There are the usual notes on foreign armies and reviews of military periodicals, and the whole publication is a credit to the Association, which is responsible for its direction.

The numerous Irishmen in the British Army will follow with interest the free flow of Celtic military thought, untrammelled by the restraint of the Saxon connection.

E.E.D.-S.

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COAST ARTILLERY JOURNAL.

(June, July, August and September, 1929.)

The June number begins with an article on " Anti-Aircraft Defence Tactics with a Mechanized Force," in which the writer first describes the different functions of a mechanized force. He then assigns to an efficient covering A.A. unit the following characteristics:—

(*a*) Easy cross-country ability.

(*b*) Speed not less than the average speed of the force it is designed to protect.

(*c*) Ease of changing from travelling position to firing position and *vice versa*.

(*d*) Rapidity in engaging targets.

(*e*) Fire power.

Of the three guns used in the American A.A. units, he considers generally that the 3-in. M.I. mobile gun, on a trailer mounting with large-size balloon tyres, fulfils conditions as enumerated in (*a*), (*b*), (*d*) and (*e*), but takes twenty minutes to come into action; the 37-mm. automatic gun, with its 80 rounds a minute, fulfils (*a*), (*b*) and (*d*), but has a vertical range of only 10,000 to 12,000 ft., and takes nearly as long as the 3-in. gun to come into action (" the operation taking less time than the 3-in. gun ") ; the 50-calibre M.G., when mounted as a four-gun mount on a light trailer, with its 450 rounds a minute, would fulfil (*a*), (*b*), (*c*) and (*d*), but has a vertical range of only about 6,000 ft. In conclusion, the 3-in. gun is the only weapon which might keep enemy bombers at a high altitude and render it more difficult for them to make accurate shooting, but none of the weapons could prevent an attack by fast fighters, while the mechanized force was on the move. He deduces the opinion that the best defence, while on the move, would be put up by the 50-calibre multiple-mounted M.G.s, but efficient protection while in bivouac can be maintained by the 3-in. and 37-mm. guns, which would, in that case, be always ready for action.

An essay on the " Army Mine Planter Service," shows how submarine mining has always remained an integral part of coast defence, under the Chief of Coast Artillery. Both the work and even the interest in the work seem to have declined since the War, so much that the Chief of C.A. has issued stringent orders this year, stressing the importance of this part of the defence training, and requiring all units to plant full groups of 19 mines at practice, instead of only fractions of these groups, as has lately become the custom.

Articles on the " Training of the National Guard," and " Details of Method and Material for Dismounting Heavy Guns and Carriages," are followed by a discussion of the mechanization of Europe. The principal portion of the latter is devoted to a very interesting disquisition on the prevailing military situation of Russia, where the authorities follow Lenin's policy that, " the soundest strategy in war is to postpone

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operations until the moral disintegration of the enemy renders the delivery of the mortal blow both possible and easy." "Communism is frankly imperialistic with the world as the limit."

The author tells how, "in September, 1928, the effectiveness of air and gas defensive measures was tested in a manœuvre at Kiel, a Ukrainian city of some 525,000 inhabitants." "Business activities were practically suspended during the manœuvres, and the entire civilian population co-operated enthusiastically with the military authorities." "The armed forces include 250,000 secret police (O.G.P.U.), 600,000 regulars on active duty, 500,000 men in the regular army reserve and 800,000 in organizations which correspond to our National Guard Reserve Units," *i.e.*, Territorial Army, while the available man-power is given as about 15 millions. Russian military aeroplanes are said to be under production with gas-proof hulls and oxygen containers for purifying the air in the fighting compartments, together with devices for emitting lethal gas and toxic smoke. "Directions have been issued for the formation of independent mechanized units and for large numbers of tank regiments, and regulations for their training have been published."

The writer on "The Organization and Employment of British A.A. Artillery," comes to the conclusion that, "in technical development we are probably far ahead of Great Britain, in tactical principles we are on a parity, but in the conception and execution of a combined defence they are probably ahead of us, due to the experience gained in the annual combined manœuvres." He had drawn attention to the fact that the British A.A. defence units have twice as many A.A. guns, and eight times as many searchlights, as the corresponding United States units.

Another writer relates a dozen instances of "Panics," which beset troops during war, with a view to familiarizing the younger generation of military men, who are as yet without war experience, with the nature and substance of panics, the circumstances that gave rise to them, and the means taken to suppress them. Measures for quelling panics should be taught to every officer. Panic seems much more liable to overcome bodies of men at the beginning of a war, and only seems to occur very rarely when they have become inured to its conditions. Most of the examples occurred in August, 1914. Also, the mass suggestion of utter fear will often corrupt a body of men when the same conditions would fail to overcome the unweakened discipline and high instincts of a single man. One of the most powerful prophylactics is tradition.

There are also two articles in a very condensed diary form of the "Atalanta Campaign," and "The Cavalry in the Atalanta Campaign."

In the July number there is an article on the "Mobility of the New 3-in. Gun, A.A.," with its recently issued trailer mounting (M.I.). A motorized Coast Artillery (A.A.) regiment of the U.S. Army, marched from their permanent station at Fort Totton, New York (near Brooklyn, N.Y.), to the practice camp at Fort Storey, Virginia (near Cape Henry, Va.), for its annual target practice, including fire against gliders, in conjunction with the U.S. Air Corps.

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The regiment consisted of :—

Headquarters and band.	
Headquarter's battery.	
Service battery.	
1st Battalion :	Headquarter's detachment and combat train.
	Battery A. (searchlights).
	Battery B. (four 3-in. A.A. guns on trailer mounts, M.I., 1918).
	Battery C. (four 3-in. A.A. guns on trailer mounts, M.I., new model).
2nd Battalion :	Battery E. (machine guns).
	Battery F. (machine guns).

The convoy of the 1st Batt., which is given in detail, consisted of eight 3-in. A.A. guns and 76 other mechanized vehicles. The 520 miles was covered in 10 days, at an average speed of 52 miles in a day of slightly less than 11 hours, showing an average rate of 4.8 miles an hour, including the 10 minutes' stop every hour. Three-ton F.W.D. lorries were used as tractors for the guns, and other trailed loads : they were fitted with solid tyres and 36 H.P. engines ; most of them were old. In some cases they could not pull the guns up short steep grades. The new 3-in. A.A. gun trailer was fitted with 40 in. x 9 in. balloon tyres, inflated to 55 lb. per sq. in. The gun is equipped with a removable liner : m.v. 2,600 f.s., giving a vertical range of 10,000 yd., and a horizontal range of 15,000 yd. : rate of fire up to 25 rounds per min.

With the new mounting the trailer can be drawn at 25 m.p.h., without undue strain, sway or vibration, and over good roads at 40 m.p.h. One 5-ton caterpillar was supplied to each battery to take the A.A. gun mountings into action over bad country or to assist ditched vehicles. The author of the article thinks that the greater part of the trouble met on the road was caused by the poor quality of the type of enlisted personnel (*i.e.*, the private soldier) now being recruited.

On one day of the march, 10 of the F.W.D. lorries were towed into camp at the end of the day. On the last day of the march, one F.W.D. lorry had to pull into camp, besides its own 3-in. gun, a travelling kitchen, and another disabled F.W.D. lorry. During the march a number of the lorries had to be left behind at an arsenal, and other efficient lorries borrowed to replace them. A maintenance section had to be organized to march at the tail of the convoy to patch up and bring on the lame ducks. During the manœuvres of the Experimental Mechanized Force of the U.S. Army, in the summer of 1928, single daily marches of similar units covered 70 or 80 miles on several occasions.

Another writer on " The Development of Heavy Artillery during the World War," states that the years 1914–15 were the years of the howitzer and the mortar. Howitzers had a tendency to increase in weight for destructive and counter-battery fire. Trench warfare in 1916 saw the development of more powerful howitzers, long-range and Q.F. guns firing by the map, sound-ranging and gas shelling. Heavy naval guns were put on railway mountings and long-range destructive fire increased. In 1918, a revulsion was caused because all these heavy-weights were

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unsuitable for fluid warfare, but the writer fails to draw any conclusion as to the future from a well-begun essay.

The series of articles on " Colonial Coast Forts," is continued, with a description of the Hawaiian Islands, which form one of the keys of the Pacific. They appear to have been discovered by some shipwrecked Spaniards as early as 1527, but Juan Gaetano, in particular, is credited with having located them in 1555. Spanish buccaneers made use of them in the seventeenth century till they were sighted and definitely re-discovered by Capt. Cook, on January 18th, 1778. At that time, the four principal islands, Hawaii, Mani, Oahu and Tanai, constituted four separate and independent kingdoms. Later on, Kamehameha I., Prince of Hawaii, rose to power and had made himself master of them all by 1810, with the assistance of two white men, named John Young and Isaac Davis, who had been captured from the vessels of an American fur trader, in 1790.

In 1815, the Russians attempted to establish a trading settlement in Hawaii and built some forts. Kamehameha soon realized the value of permanent fortifications and built a strong fort at Honolulu, under the supervision of John Young. It was completed in 1816. It was square in trace, with sides of over a hundred yards in length, while the walls were 12 ft. high and 20 ft. thick. At first it mounted forty pieces of different sizes, varying from 6-pr. to 12-pr., but later eight 32-pr. were added. The site is commemorated to this day by the name, Fort Street. Another defensive post with guns at Punchbowl Hill completed the security of Honolulu. In 1849, the fort is reported to have mounted 70 guns, but this number on a 400–500 yd. perimeter seems excessive. It was during this year that the French dismantled it, owing to an unfortunate misunderstanding, and in 1853, it became a prison. In 1894, Hawaii deposed its Queen and became a republic, only to be annexed by the United States in 1897.

The island of Guam was discovered in 1521, by Magalhaes, during his historic voyage of discovery round the world. In 1565, it was taken possession by Lopez de Legaspi, in the name of King Philip II. of Spain, and the first settlement was effected three years later, the garrison consisting of a captain, a priest, and 32 men. The natives soon rose in revolt, till in 1674, Don Damian de Esplana arrived as Military Governor, with an increase of garrison. It took them 21 years to complete the conquest of the island.

The Spaniards built a number of forts along the shore to protect the island from enemies and buccaneers. Umata Bay was strongly fortified with four forts. By 1817, Port San Luis d'Apra was also heavily defended. In 1898, the U.S.S. *Charleston* had been ordered to take possession of Guam. The Americans entered Port San Luis, and opened fire, but found that all the forts had been abandoned and allowed to fall into disrepair some years previously. The Spanish Governor had not been informed of the outbreak of war and thought that he was being given a salute from a friendly vessel, till the boarding officer from the *Charleston* arrived to take possession. The island was surrendered to the United States and formally annexed in 1899.

The August number contains further information as to the new 3-in. A.A. gun. The writer tells us that a battery firing at maximum rate, imparts 80,000 foot-tons of energy to its projectiles, or more than half as

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much again per minute as a 12-in. mortar battery firing two salvoes at a battleship every 45 seconds. The gun fires from a star-shaped platform, with four spider legs to give it stability: these legs are folded up and carried on the trailer with the gun when on the march. The stereoscopic height-finder, on the Barr and Stroud principle, has an optical base of 4 metres: the scale readings of altitude are transmitted electrically to the director. The data, as computed, are continuously indicated on dials on the guns, which can thus be kept continuously and correctly laid. The fuze-setter is also of the continuous type, which keeps on changing the setting for the fuze to correspond with the ever-changing data, until the round is removed.

The searchlight at present in use consists of a 150 amp. arc-light, enclosed in an aluminium drum, and backed by a 60-in. parabolic mirror. It has 360 deg. traverse and 90 deg. elevation. It is fitted with ventilating motor and fan, thermostatic carbon control with a manually-operated occulter.

The sound-locator is carried on a low, 4-wheeled travelling platform, and consists of 4 trumpets of square section, with seats for the listeners.

Another article on the same subject gives a slightly different class of information.

The story of the successful Confederate attack on Fort Sumter, on 12th April, 1861, is told. How it was held by Major Robert Anderson, of the Federal Artillery, with about 60 men. There were other forts dotted about Charleston Harbour, but when the South seceded, Forts Moultrie, Johnson, Castle Pinkney and Morris Island, had to be abandoned, because of the impossibility of holding them with such attenuated numbers. They were practically trapped, though war was not yet declared.

Early in January, 1861, a ship, with troops and stores, tried to steal through in the dark, but was spotted, and an alert Confederate gunner fired the first shot of the American Civil War, to turn her back. In April, Anderson was forbidden to purchase any more food in Charleston, and the investment began. At 4 p.m., on the 11th April, the Confederate general demanded surrender, and upon refusal by the garrison, he gave notice that he would open fire on the following day. Consequently, at 4.30 a.m., the South opened fire, and at 7 a.m., the North replied from the fort.

At 3 p.m., three Federal ships appeared off the harbour with help for the beleaguered garrison: it had been arranged that they should run in under the heavy covering fire of the Federal man-of-war *Powhattan*. Unfortunately, someone had blundered, and the *Powhattan* had already been ordered to, and had started for, another destination. So, with empty magazine and depleted larder, with the interior of the fort a roaring furnace, Fort Sumter surrendered at 7 p.m., on the 15th April; the commander accepted the easy terms offered by his chivalrous enemy and prepared to embark with his men on some Union vessels in the harbour and sail away to the North. For the last time, "the flag of the Union is hoisted and a salute fired in its honour. During the firing of the salute some of the loose powder explodes, killing one Union soldier and wounding several others. Thus, in a ceremonial after the battle, is killed the first soldier of the great war."

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So, apparently, there were no casualties during the siege.

A lieutenant in the First Gas Regiment of the U.S. Army has contributed a short article dealing with protective clothing, of which he says that, " the latest type is very light and comfortable and offers very complete protection against blistering liquids." No details, however, are given.

The September number contains an article on " Mine Defence—To-day and To-morrow," bewailing the low status into which submarine mining in the U.S. Army has been relegated. He also describes an economy in submarine firing control by means of a synchronized pair of revolving selectors, which can give control over twenty mines through one cable, thus obviating the necessity of having twenty lines. A revolving contact arm inside each mechanism provides a means of obtaining a clear line to any one mine when required.

Another article also laments the fate of the submarine mining officer of to-day, who cannot get away from that branch of the Coast Artillery to widen his knowledge of gunnery, because there are so few officers qualified in mine defence work.

The new Christie model of tank is described as having the best heavy chassis in the world up to date, for transportation needs of all kinds. " Christie has given us, in his new machine, more technical progress than Great Britain has secured during the past ten years, for the expenditure of some sixty million dollars. However, in technical methods and practical experience with fast fighting-machines, the British Army is far ahead of us."

The author does not seem to give credit for all the costly and hard-won information used by Christie, but gained by us.

D.M.F.H.

THE BUILDER.

In the issue of September 13th, 1929, a description is given of the cork tile flooring, made by the Cork Insulation Co., Ltd., of 14, West Smithfield, London, E.C.1. It is described as hard-wearing, warm, noiseless and non-slippery. It is manufactured of ground cork, compressed and baked in moulds. It has been seen by the writer, and is of a pleasing brown colour in three shades. The tiles are made in two thicknesses, 9/16ths inch and 3/8ths inch, and in varying sizes from 6 in. by 6 in. to 12 in. by 36 in. The price for a minimum of 25 sq. yd. in the London district, supplied, laid and polished complete, is 17s. 6d. a sq. yd. for the thicker, and 15s. a sq. yd. for the thinner variety.

D.M.F.H.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*January–February*, 1929.)—*The Campaign against Roumania*, 1916. The report of a lecture, delivered by Lt.-Col. Kissling, before the Military Scientific Society of Vienna. The lecturer quotes amongst his references the works of Averescu, Conrad von Hoetzendorf, Falkenhayn, Hindenburg and Ludendorff, in addition to which, as an official at the Austrian War Archives, he has easy access to the war diaries of all formations. He recommends the Campaign as containing, perhaps more than any

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other in the Great War, a very great deal of interest, because in it appear in a comparatively short time: fighting retirement, offensive in open country, mountain warfare, wide-sweeping use of cavalry, the capture of a fortress by *coup de main*, river crossings on the largest scale, the use of river monitors, etc. He also claims that the campaign shows how, on one side by unity of command, all obstacles were successfully surmounted, while the difficulties of carrying on coalition warfare brought the other side to destruction. Lt.-Col. Kissling's method of dealing with his subject is instructive. After setting the scene by a short exposition of international relations, before and since the Treaty of Bucharest, and by discussing the war plans on both sides, he runs over the chief events of the campaign, their origin and their effect on both parties, the considerations weighed by the commanders and what led to their decisions.

The first instalment takes us as far as the clearing of Siebenbürgen by the Germans and Austrians, while on the other wing, the Roumanians and Russians had just brought the Bulgarian advance in the Dobrudja to a standstill.—(*To be continued.*)

Guerilla Warfare and the Means taken to Combat it in the Occupation of Serbia. This article is composite; the first half, by Maj.-Gen. Kerchnaue, dealing with the organization of the Austrian Government forces in the occupied territory, and with the course of the operations which took place there; while the second half is by Capt. Maulik, and rehearses the various characteristic methods of dealing with guerilla warfare. The editor thinks it necessary, in the face of more serious and more likely forms of warfare, to start with a short apology for introducing to his readers anything so comparatively unimportant as guerilla warfare, an apology which would not have been necessary in introducing the subject to British officers, or, indeed, to officers of any power, holding possessions in Africa or in Asia. The value of success in combating guerilla warfare was in any case abundantly proved in Serbia, since it permitted a material exploitation of the occupied territory which, according to the Q.M.G. at Austrian G.H.Q., was of decisive importance for the further prosecution of the war in other theatres. The Austrians took the wise step of supplementing, by means of enlistment among the natives, the 70,000 second-line troops and Gendarmerie, which were all that they could spare to form the Army of Occupation. Such enlistment was restricted to the Mohammedan population, which could be relied upon to regard the Austrian occupation as a release from the hated Serbian rule.

In a few months this measure provided 30,000 irregulars, knowing the country and already trained in guerilla warfare, of which Serbia furnishes, as it were, the classic example.

Apart from the services rendered in rounding up bandits, the formation of this force of natives enabled 18,000 of the garrison to be released for the field. Photographs show some very useful types, Turks and Albanians, including mounted scouts. Exception only must be taken to the *white* Albanian fez. It is hoped for the wearer's sake that it is less conspicuous on a hillside than it is on a photograph.—(*To be continued.*)

Armoured Trains, by Capt. Wagner. The author looks upon an

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armoured train as a battery capable of escaping danger by its superior power of manœuvre, and, by reason of its armour and its many machine-guns, capable of taking part in the foremost lines of infantry action.

Different make-ups of A.T. are shown by sketches, the fighting wagons varying from three gun wagons with one gun and one heavy m.g. (two ports) each, and one wagon for O.C. and ammunition, with three to four heavy m.g's., to a train containing as fighting wagons only one gun wagon, one O.C.'s and ammunition wagon and one m.g. wagon. All guns fire from movable cupolas, and all m.g's. through ports, except that an m.g. turret is provided in the O.C's. truck.

The Russians, from 1918 on, distinguished two kinds of armoured trains. Light A.T.s carried guns up to 3 in., were heavily armoured, and worked mostly in line with, and often in front of, the infantry. Heavy A.T.s carried guns from 3 in. to 8 in., were less heavily armoured, and were generally brought into action among the light position artillery. For tactical purposes an armoured train division was often built up, consisting of two light A.T.s, one heavy A.T. and one breakdown train, which was also a work train for larger permanent way repairs.

Steel armour on these trains was often replaced by concrete, up to 6 in. thick, with great success.

The author then gives us, from his own experience, detailed account of A.T. action in the neighbourhood of Libau in June, 1919, when the Germans were fighting the Esthonians. The descriptions become thrilling, especially when train fights train. One fight lasted exactly one minute! In another, which lasted seven minutes, the author's train received seven direct hits. It comes, then, as a relief to read, "The next day we spent in repairs."

In this short report, we see the armoured train most variously occupied, in close fighting, in long-range fighting, as ammunition transport, as wounded transport, as breakdown gang, as scout, as rearguard, in attack, and finally doing police work amongst civilians storming the railway stations. An excellent testimonial closes the account, "In whatever capacity the armoured train appeared, it was always joyfully welcomed by the other arms."

The New Musketry Regulations, by Maj.-Gen. Büttner, Inspector of Infantry. These have appeared recently in three parts: (1) General Theory of Projectiles, and Aids to Shooting; (2) Instructions for the Use of Rifle, Light Machine-Gun and Pistol; (3) Instructions for the Use of Heavy Machine-Gun.

The issue of these regulations marks the transition from the m.g. as auxiliary of the rifle, and as weapon of occasion to the m.g. as the chief bearer of the infantry fire fight.

Signals in Mountain Warfare, by Major Werner. This is no exhaustive treatise on the subject, but a good example of a thoroughly practical article. The writer draws upon his experiences as a signal officer in war during winter in the mountains. Heights above sea-level were from 4,500 to 7,500 feet, so that it was necessary to defeat depths of snow up to 20 feet, in addition to snowstorms and avalanches.

A cable line for the winter is best laid on the surface of the ground, as soon as the latter is frozen. The cable must carefully follow every inequality of the surface. Every quarter-mile or so, a 30-ft. loop is

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twined round a six-foot pole. After every heavy fall of snow the linemen lift the poles, and stick them into the fresh snow.

Fresh routes required during the winter are buried in the snow, preferably in the bottom layers where movement by side-slipping is less likely. Ordinary field cable will remain good for months like this.

Armoured cable is used if available, but it is not avalanche-proof.

Major Werner then gives us two successful examples of the use of lamp-signalling, drawn from the 11th and 12th Isonzo battles. The Commander of the 7th Austrian Mountain Brigade was a great believer in lamp-signalling, a statement for which one is not unprepared, since a brigadier who demands visual communication is likely to bear its necessities in mind when choosing headquarters, and is certain to get back in good service what he has expended in interest.

The two examples show lamp-signalling rendering invaluable services in a defensive battle, and in a victorious advance. In the latter case, it was able to carry out both quickly and safely what line communication could at best do slowly and precariously.

The author concludes: "This does not imply that lamp-signalling alone can be the mainstay of communication; but rather that, properly applied and served, it is able to bridge over a break in communication of some duration. It is a very valuable auxiliary to telephonic communication, and can often replace it. Especially in mountainous country it reaches its highest value. In pursuit of the enemy it is a quickly movable means which can always accompany the pursuing troops."

All this may be heartily endorsed, the words "properly applied and served," being understood to exclude any attempt, as sometimes made, to extemporize a visual service, as, indeed, excluded by the German and Austrian Armies, which, realizing that visual signalling to be effective must be in constant use, keep their lamp-signallers apart.

The Development of Artillery Material since 1914. In honour of the tenth anniversary of the end of the War, Major Heigl made a slight diversion in his series of articles, by devoting the last instalment entirely to the most powerful weapon used against the Austrians, the Italian 30·5-cm. howitzer. He now returns to the other heavy siege howitzers. Of these in general, he says that the kind and quality of most guns can only be of importance for the issue of a campaign in their totality; but to this rule, the siege howitzer is an exception. The fate of a campaign can depend upon it, upon its performance and mobility. Without the timely fall of Port Arthur, there would have been no decisive battle of Mukden: without the speedy fall of the Belgian fortresses, the long, devastating War would have taken place, not in France, but in those frontier provinces of Germany, which were so important for war industries.

From this peculiarity of the heaviest howitzers arises the necessity for strict secrecy; and there were few who knew that 28-cm., regarded before 1914 as the largest calibre for land warfare, had been far surpassed by both Germany and Austria.

The 28-cm. howitzer of the Spezia type, was built by Krupp's for Italy, in 1879. The Japanese bought a number of these for coast defence from the Italians, and 18 of them took part in the bombardment of

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Port Arthur, where they contributed to the surrender, both indirectly, by piercing the concrete, and directly, by killing General Kondrachenko, "the soul of the defence." Ten years later, in 1915, the Russians, being very short of *matériel*, owing to their losses in retirement, bought these howitzers from Japan, and used them against the Austrians. During the offensives of 1916–17, in Tyrol, very many of these Italian howitzers were captured by the Austrians, both in their original design, and with a lengthened barrel. A photograph shows the latter type.

In the matter of the heaviest howitzers, Germany led the way by building, in 1907–09, in the strictest secrecy, their 42-cm. howitzer, later to become famous. It was a master performance of the celebrated gun-designer, Prof. Rausenberger, has all the appearance of being intended for coast defence, but was, as we now know, meant from the first for siege purposes. For secrecy, it was known as "The short Naval Gun," and by other code names. Some idea of its size is given by stating that the pit alone was 12 yards long, and the muzzle at maximum elevation of 65 degrees, was 26 feet above the ground. A photograph is given. In 1914, there was much puzzling over this monster, and one English artist drew it on a railway mounting, a picture which must have been on the other side of the line "a source of innocent merriment."

The Austro-Hungarian 30·5-cm. howitzer is also shown by a photograph, in position on the Russian front. It comes in the same category as the 42-cm., as a secret siege howitzer, and contributed likewise to the precipitate fall of the Belgian fortresses. It is transported in three units, drawn by one 100 h.p. tractor. The remaining howitzers described with photographs or drawings are:—

The Austrian 24-cm., dating from 1900, and copied by the British at the time of the Boer War as our 9·45-in. howitzer.

The French 280-mm. M14 Schneider of 1909; and the French 370-mm. Filloux, which designed apparently in the 'nineties, was still only on paper when the War broke out.—(*To be continued.*)

The International Situation, by Col. Paschek. This is a sturdy attempt to run briefly, country by country, through those events of the year (1928), which have a bearing on international relations or politics, and thus to arrive at a summing-up of each country's position and tendencies. The notes are well thought out, objectively written, and make entertaining reading.

The Official Austrian History of the War, by Maj.-Gen. Kerchnaue. Thanks to the initiative of the War Archives Directorate, and to the publishers of *M.M.*, the greatest obstacles have been overcome, and the "General Staff History," as it is popularly called, has started to appear.

It is planned in five to six volumes of six parts each, appearing one volume every year, starting with 1929. Price of Vol. I, 40 Austrian schillings = £1 5s., or bound in half linen, £1 8s.; to be obtained from the publishers of *M.Mitteilungen*, Vienna I, Stubenring 1.

On the same scale as previous histories issued by the War Archives —*e.g.*, the Campaign of 1809, which lasted six weeks, four large volumes; and the Campaign of 1866, which lasted five weeks, five volumes—this history would have comprised 175 to 180 large volumes. Gratitude should mingle with congratulations.

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(*March–April* 1929.)—*The Campaign in Italy in* 1849, by Col. Baron Wolf-Schneider. The Campaign is used as a good introduction to a panegyric on the great Field-Marshal Radetzky, the victor at Custozza. The author does not hesitate to mention him in the same breath as Frederick the Great and Napoleon; and Radetzky certainly seems to have possessed all the qualities of leadership, from that of inspiring confidence and admiration bordering upon worship, through iron resolution, to the faculty of selecting the right man for the job, and then giving him the chance to develop to the fulness of his powers.

Guerilla Warfare and the Means taken to Combat it in the Occupation of Serbia (*continued*). Maj.-Gen. Kerchnaue finishes off his share of this article. Incidentally, he gives us an example of how it should not be done, which might serve as a theme for the talented author of *Duffers Drift*.

Four coys. of irregulars with half a squadron and one battery of 9-cm. were occupying village B, to protect it from the rebels. Three more coys. with three m.g. sections, were sent as a reinforcement, and the whole force ordered to advance to village P, to relieve pressure on allies. Because a party of his dragoons had been ambushed and cut up in a defile in his rear, and because he had received exaggerated reports of the rebels' strength, the O.C. Force disobeyed this order. (*Note.*—The actual strength of rebels transpired later to have been two parties of 15 men each.) Instead, he sent out a reconnoitring party, which came under long-range fire (2,000 paces and more) and remained in action all day, firing in three directions, until it ran out of ammunition. A company which was sent out in support of it, did the same. Total casualties *nil*, ammunition all gone.

This brisk fusillade made none the less a great impression on both sides. 1,500 rebels (half with rifles and half with hand-grenades) were brought up, surrounded B, and attacked it at night, but were driven off by m.g. fire. Losses on both sides "considerable." Both sides considered themselves defeated. The rebels fled in disorder, while the irregulars evacuated the village and retired in the other direction.

Gen. Kerchnaue calls the foregoing a classical example of how unsuitable untrained troops, under inexperienced leaders, are for dealing with guerilla warfare.

It is that and more; for, considered from both sides, it shows that for war, guerilla or otherwise, one needs people trained and people disciplined, in fact, soldiers.

The remainder of the article is by Capt. Maulik, and embodies his experiences fighting and trying to outwit rebel bands for fourteen months. The difficulties caused by the civil population supporting the rebels; the impossibility of enlisting an intelligence service; the hiding of weapons at the critical moment, and playing the peaceful peasant; all these features, well known to British officers from S. Africa, Burma, the N.W. Frontier, and from Ireland, appear.

The methods tried and their results are:—

1. Encircling and driving. These elaborately-organized "combings" had no success. At the end the net was always empty, owing to various reasons, such as, insufficient search of the country

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lying between paths and routes; the troops drawing together for rations and rest, etc.

2. Driving by patrols against a line of pickets. This system was also a failure. The drives took much time to arrange, and the quarry was often away before they started. Also the patrols did not keep direction well, and both the line of pickets and the closing line of patrols were passable.
3. Occupation by small detachments, 10 to 12 men, of the rebels' re-victualling points. This system did not succeed up to expectations. The villages were very hard to control, being both wide-spreading and containing much cover, such as maize-fields. The villagers also had their own warning posts, often using children for the purpose. Also, all possible villages could not be thus occupied by troops, and the rebels quickly changed to those which were not occupied. A bad feature was that discipline amongst the troops soon suffered through lack of control.
4. Ambushes. This was the best system tried so far. The chief difficulty was the unnoticed occupation of the ambush. Also the long waits, perhaps weeks waiting for a catch, were bad for discipline.
5. Counter-guerilla bands. A band of 15 to 50 men was formed under a very specially selected leader, for the sole purpose of chasing down a particular rebel band. They had nothing else to do or think about. This was the best system of all, and in one district alone, during the summer of 1918, four large rebel bands, each under a well-known leader, were chased down and wiped out.

Two Light Machine-Guns, by Capt. Däniker, Swiss Army. The light machine-guns here described are the French *Fusil mitrailleur* 24, and the Italian *Mitragliatrice leggera Fiat*, 1926 pattern; and they have been chosen as representing different directions of development of the light m.g. of the future.

On the appearance of the light m.g., firing rifle ammunition, certain difficulties arose from the lightness of the weapon, which had to fire a powerful cartridge at a great rate. Also, it appeared that the rifle cartridge for this weapon, which was only intended for short-range use, gave a certain excess of performance.

From these two considerations arose two possibilities of development. The first was, should not the light m.g. with its carriage, be built somewhat heavier, so as to utilize the good ballistic properties of the bullet at longer range? The affirmative answer to this question led to the construction of light carriages for light m.g's., as in the Hotchkiss, Madsen, KE7, and the Czecho-Slovakian ZB26. This is the road to the medium-heavy machine-gun, as is shown even more clearly than in the models mentioned by certain Italian types, the Breda (*vide R.E. Journal*, March, 1929), the Fiat light m.g., 1924, and the 1926 pattern of the latter, one of the subjects of the article. These three last-mentioned are really medium-heavy m.g's., and, as they will no longer be able to fulfil all the requirements of a light m.g., sooner or later there will be a demand for a type intermediate between them and the rifle.

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The other possibility was to build the weapon for a lighter bullet. This light bullet with high muzzle velocity gives a very flat trajectory for short ranges. It is no disadvantage that, as the German S-bullet shows, the flight becomes unreliable at long ranges, because the light m.g. will not be used at long-range.

But, since in the infantry coy. there must be only one kind of ammunition, rifles and automatic rifles must follow suit. This is all to the good, since they also are short-range weapons. Further, the automatic rifle will gain in lightness and handiness.

A necessary consequence will be a separation of ammunition between the automatic rifle and light m.g., on the one side, and the heavy m.g., on the other, since the heavy m.g. must keep its heavy bullet. Disadvantageous as this separation is, it was bound to come somewhere, and is better here than between automatic rifle and light m.g. It also makes possible the granting of certain other demands which are always cropping up, *e.g.*, a still heavier bullet for the heavy m.g.; and a larger calibre, possibly to the extent of making it an anti-aircraft weapon.

The French with the *Fusil mitrailleur* 24 have adopted the second method. They have reduced the weight of the bullet to 9 grammes, and the calibre to 7·5 mm.

There appears little doubt in Capt. Däniker's mind that the French answer is the correct one (*cf.* his views in *R.E. Journal*, March, 1929).

Anti-Aircraft Defence. Under this heading follow certain articles which really belong to the encyclopædia on aerial warfare, published last year by *M. Mitteilungen*, under the title of *Luftflotten* (reviewed in *R.E. Journal*, March, 1929), but which were crowded out. They are:—

"A.A. Guns and Machine-Guns," by Lt.-Col. Milhard, Czecho-Slovakian G.S.

"Range-Finders," by Capt. Maurer. (Shows clearly why the monocular invert is better than the stereoscopic.)

"Position-Finders working by Sound," by Capt. Schubert. (Shows how the Goerz direction-hearer, which is monotic, is superior to all the diotic instruments, the *Télésimètre* Perrin, the German *Doppelrichtungshörer*, and the American exponential hearer.)

"Shooting at Aircraft," by Maj.-Gen. Scheiner. (Worked out graphically and mathematically; (*a*) for machine-guns, (*b*) for artillery.)

"Kite Balloons for Night Defence," by Lt.-Col. Hirsch.

A New A.A. Gun by Bofors. The well-known Swedish gun firm of Bofors has brought out since the War a number of A.A. guns up to 10·5-cm. calibre, some on lorries and some on what the firm calls the field air-defence carriage. The principle is not new, having been introduced towards the end of the War by Skoda for the Austrian Army, and by Krupp for the German Army, without, however, reaching the front.

The mounting of the new 7·65-cm. field Anti-Aircraft defence gun Bofors consists of a central pivot on four arms, which lie flat on the ground, in the shape of a cross. The object of the arrangement is to afford 360 degrees field of traverse, and greater elevation, in this case 85 degrees.

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Three of the arms have ends which can be adjusted to uneven ground. For transport, the arms are detachable, and are slung under the axle of the same pair of wheels as carries the gun and pivot.

F.A.I.

HEERESTECHNIK.

(*January*, 1929.)—*Instructions for the Administration of Regimental Stores and Equipment.* Can only be read in conjunction with the Regulations on the subject, H.Dv 488, which it elucidates.

The Recent Italian Publication on External Ballistics. (*Balistina esterna*, by Lt.-Gen. Cavalli, Professor at the School of Application for Artillery and Engineers.) This textbook of external ballistics claims our notice through the wealth of its material, and the clearness of its exposition. Gen. Cavalli, as a pupil of the celebrated Italian ballistician, F. Siacci, who died in 1907, devoted himself to the task of carrying on and perfecting Siacci's methods. The book is dedicated to Siacci's memory. The letterpress is much lightened by numerous completely-worked, practical examples.

The contents of the chapters are then given *seriatim*. In Chapter VI are defined Siacci's four primary functions and four secondary functions, with the geometrical signification of the latter for any point on the trajectory.

The German Railway Guns in the Great War on the Land and Coast Fronts. The initial successes of the heavy artillery, which surpassed all expectations, led to the extension of this arm, and in especial to the introduction of the long barrel, so as to obtain low-angle fire of the heaviest sort. The task of making land guns out of naval guns, which could be spared, fell upon the navy, which was called upon at the same time to find the necessary ordnance for fortifying the coast of Flanders, and for strengthening the coast defences of Germany.

The first guns which could be made available were 16-in. reserve guns. To these were added from the scrapping of the battleships of the old *Kaiser* class a large number of 9·6-in., then, after the loss of the *Prinz Adalbert* and *Blücher* and the *Scharnhorst* class, a number of reserve 8·4-in. guns of these ships. After the scrapping of the battleships of the *Brunswick* class, following the Skagerrak battle, 11·2-in. guns became available. Also should be mentioned a 14·2-in., which had been used before the War for trials at Krupp's, six 11·2-in. of the *Brandenburg* class, and four 9·6-in. from the old *Oldenburg*.

All these guns were placed on mountings which had been erected, by means of powerful cranes, upon concrete beds; such mountings consisting principally of a built-up framework supporting the trunnions. The placing of a heavy gun thus on a concrete bed took eight weeks, exclusive of the provision of bomb-proof shelters, ammunition chambers, travellers, etc. Besides this loss of time, there was also the loss of material when a gun's position was changed. A new method had, therefore, to be found, and for land-front guns, the concrete bed was replaced by an iron bed, capable of being dismantled and re-assembled. This reduced the time from starting work to the firing of the first round to 35 days, for the heaviest guns.

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The change from concrete to iron beds introduced, however, a fresh trouble. The lack of cranes was soon felt. The number of heavy guns to be mounted was increasing, and the cranes were necessary at each gun position for a longer time.

Twelve cranes were, therefore, built for guns up to 11·2-in. They could lift up to 60 tons, and did not take more than three hours to erect or dismantle. For the 15·2-in., there were three cranes, lifting up to 150 tons, which were lent by a firm from stock for the duration of the War.

Although iron beds, capable of removal, and quickly erected cranes both improved matters, affairs on the Western Front made a greater mobility of the heaviest ordnance necessary. A sufficient number of cranes could not be built to achieve this. Hence arose the idea of building mountings enabling guns to fire from the railway trucks used for their transport. Amongst the rolling-stock were found four 80-ton trucks, which had been built for carrying guns. Four mountings were ordered for these trucks, and in the autumn of 1916, the first trial was successfully carried out. The gun ran back on the rails 350 metres on discharge, although the wheel brakes were on. During the passage back, the gun recoiled and ran forward.

As only four of these 80-ton wagons were available, other means had to be created. Mountings were designed with longer frames, to be carried on bogies. On arrival, the mounting was off-loaded, the bogies being for transport only. Trials were satisfactory.

Two types were thus arrived at, the E or railway mounting, for guns firing only from the railway, and the B mounting, for guns firing only from a concrete or iron bed off the rails.

The next step was to combine these two ; and finally, all heavy naval guns, converted to land purposes, had an E and B mounting, so that they could fire either from the railway or from the bed.

These E and B mountings were built up to the 15·2-in. A photograph shows this beautiful bit of engineering.

(*February*, 1929.)—*Instructions for the Administration of Regimental Stores and Equipment* (*concluded*). Discusses the alterations which are about to appear in a new edition of Army Regulations (H.Dv) 488, Part 4, Signal Equipment. The endeavour which has been dominant in the revising of these Regulations is given as " to fulfil the known wishes of the troops and to lighten as far as possible their work of administration."

The Manufacture of Army Saddles. From the cutting of the hide into fifty-five shaped pieces, Major Giesecke, with the aid of over thirty photographs, takes us through all the processes to the finished article. He leads with emphasis to his point, that a saddle being destined for wear by a living being, and having its most important part, the saddle-tree, made of wood, and thus subject both in preparation and in the course of time to change, can never be turned out as, for example, a fuse is turned out. Even when the saddle is drawn from ordnance in fourteen sizes, the regimental master-saddler must have the last word.

The Recent Italian Publication on External Ballistics. Professor Cranz, himself one of the world's greatest authorities on ballistics, finishes his review of Gen. Cavalli's book. He finds that the later German measurements of air resistance (1912), also the German methods of successive

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approximations, especially the procedure of isoclines, are not mentioned at all, and can only attribute these omissions to the author's belief that no essential progress has been made since 1907.

He considers it would be instructive to test by means of several numerical examples, whether trajectories reaching great heights can be both quicker and more accurately calculated by Siacci's methods, or by the methods of Veithen-Kutta, Wiener, etc., or by the recently published (1924 and 1927) methods of von Eberhard.

The German Railway Guns in the Great War on the Land and Coast Fronts (*continued*). Part II of this article consists principally of photographs and diagrams illustrating Part I. They are :—

The first mounting and bed prepared by the navy for a heavy gun in land warfare, the 15·2-in., at Loison, near Verdun.
Mounting for Krupp's experimental gun, 14·2-in. ; made also to take 15·2-in. ; used at Quéant, Sancourt and Santes.
Heavy mounting, showing early elevating and traversing arrangements.
Heavy mounting, with electrical elevating and traversing ; also 160-ton gantry.
Mounting of 8·4-in. gun on a removable iron bed.
40- and 60-ton hydraulic cranes placing a 15·2-in. gun on its cradle.
The first German purely railway gun, 9·6-in., on an 80-ton truck.
An 11·2-in. gun on E and B mounting (*vide* Part I), about to be deposited on a removable iron (or concrete) bed.
The same deposited.
The same ready to fire.
An 8·4-in. gun on E and B mounting on rails.
A 15·2-in. gun on E and B mounting, carried on 16 axles, 4 bogies.
A French mounting for 9·6-in. guns, or 11·7-in. howitzers, much used in the War, carried separately from the gun on broad, or narrow-gauge railways, or on the road, and capable of rapid assembly.
A railway mounting, built by Schneider, for 11-in. to 12·8-in. guns without barrel recoil.—(*To be concluded.*)

My Commands in the Great War, by Max von Gallwitz. General von Gallwitz's case is interesting as being much of a parallel with that of the late Lord Horne. As Inspector of Field Artillery, he could never have foreseen that he would rise above all the corps commanders, and all the army commanders, to become what was generally reserved for princes, the Commander of a Group of Armies.

What seems to have contributed very much to his success was that he was only occupied for short periods in position warfare, and that in the capture of Namur, the breaking through the Russian Front on the Narew, the passage of the Danube and in Serbia, fortune was continually presenting him with opportunities of distinction in mobile warfare.

(*March*, 1929.)—*Recent Ideas of the Importance of Meteorology for the Fighting Services*, by Dr. Kölzer. This is a fairly full report of a lecture by Commander Garbett, delivered at the R.U.S. Institution, in February, 1928. It even goes so far as to give a *résumé* of the discussion which

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followed the lecture. The author considers the whole instructive in more than one respect, as evidence of a greatly increased interest in meteorology in the navy, army and air force, in England since the War, and of the later development of the meteorological service. Both of these facts point to a complete change of opinion as regards the importance of meteorology, as compared with opinion before, and even to some extent since the War. It is obvious that they must lead to tangible advantages.

The Trade Automobile Exhibition, Paris, 1928. Large as the "Grand Palais" is, it is not large enough for cars and lorries to be shown at the same time. The exhibition of November, 1928, was accordingly limited to trade automobiles and omnibuses.

The number and nationality of the firms exhibiting was, 21 French, 3 American and 1 Belgian.

The exhibits disclosed strong conservatism in French lorry construction; types and methods being retained which have long since been abandoned in Germany, chain drive, solid tyres, very high frames, and antiquated engines. In the development of the six-wheeler, France is far behind England and Germany. Berliet, with first rear axle chain-driven, and Chenard-Walker, showed six-wheelers of 12 tons and 8 tons useful load, respectively, but neither of these is of any military value. The former is only suitable for good roads; while the latter, which is called the *Appareil 6 Roues, Tous Terrains, Type Forestier*, is intended for carrying heavy logs from the forests, but, owing to the method of drive, by chains on the wheels, has very little axle freedom. On the other hand, Berliet showed a six-wheeler, built for purely military purposes. This has all axles worm-driven. The third axle lies midway between the other two, thus needing to be built stronger and needing twin tyres. It also necessitates the rear axle being made steerable. On account of all three axles being driven, its cross-country ability is greater, but it has no greater adaptability than any well-built six-wheeler, like the W.D. pattern, with two rear axles driven. The Belgian firm, Miesse, also showed a six-wheeler on English lines, a seven-tonner of 105 h.p.

The article then mentions, with photographs, other features of the Exhibition, viz., the Citroën-Kégresse tractor, full-track, originally intended for agriculture, but now subsidized by the French War Office; a Citroën car, half-track, with body built as a wireless office; a Citroën car, half-track, with runners to take the front wheels in snow; an Ara tractor which, having done good work with the artillery in Morocco, is now subsidized. It is characterized by the method of affording a yielding support of the lower band.

As regards the details of lorry construction in France, engine power is much less than in Germany, and four cylinders still predominate. Excepting Saurer, Berliet, Panhard, Renault, Cottin-Desgouttes, and Scernia, all firms showed antiquated shapes and methods of procedure. The clutch coupling was still to be found in the majority of vehicles. This has completely disappeared in German lorries. Many gears are still separated from the engine, and nearly all have four speeds.

A perspective drawing shows the new axle-drive by Delahaye, which may replace the worm-drive. The drive is by spur wheel, which engages

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with a large spur wheel below it, so that two cone wheels on the same shaft can each drive a large cone wheel. The Delahaye spur wheel drive is thus specially suitable for any vehicle like a six-wheeler with two driven rear axles.

The use of home products for power purposes still rests mainly upon gas engines, calling for the use of charcoal or carbonite, a charcoal briquette in flat egg-shape. Gas-engine-propelled vehicles have been developed to a remarkable extent owing to military support. Competitions lasting weeks, which have been carried on now for five years, and in which thousands of kilometres are travelled under strict supervision, have caused so great an improvement that the conditions this year have again been made more severe. For example, lorries with pneumatic tyres per ton carried may not use per kilometre more than four and two-thirds ounces of wood, or one-half that weight of briquettes.

The most successful gas generators are those of the firm Rex (Gennevilliers, Seine).

Diesel engines appeared at this Exhibition for the first time. The two-cycle Junkers-Dessau Diesel engines are made under licence by Peugeot, who have had large orders for them, consequent on their success in military trials over 3,000 km.

Photographs then show a very fine four-cycle Diesel engine by Saurer, and a purely French Diesel engine by Norton, of Paris.

A sectional diagram is given of the Perrier centrifugal oil cleanser, which is extremely reliable and which reduces the consumption of lubricating oil by one-half.

A photograph also shows a small air-cooled, single cylinder engine by Renault, 1,200 revs., 1 h.p., direct coupled with a ½ kw. dynamo for lighting purposes; it stands 30 in. x 16 in. x 23 in., and weighs complete 85 lb.

Finally, neither six cylinders, and still less the six-wheeler, have appeared in French lorry construction to any noticeable extent. Also pneumatic tyres have hardly yet found an entrance.

Railway Guns. This is the third and final article on the subject, the title only being changed as German guns have receded into the background. Another type of railway gun used by the French is shown, viz., that of the 7·6-in. gun (without barrel recoil), with a range of 15 km., and all-round fire. Before firing, the centre portion of the gun truck is supported on eight screw legs, four resting on beams laid upon the rails, and four on beams laid outside the rails. The German answer to why they preferred to detrain the gun on to a solid prepared mounting, instead of thus obtaining a 360 degree traverse with a gun that did not leave the track, is that the extreme possible range with such guns was the 16 km. of the French 9·6-in., and that this range was quite insufficient for German purposes.

Photographs are given of the heaviest French naval gun mounting, only slight elevation being possible if used on the rails, and of the far more elaborate German 15·2-in., E and B mounting with all-round fire.

Besides the heavy calibres, 8·4-in. to 15·2 in., already dealt with, Germany had a number of smaller calibre railway guns, three of which are shown in photographs: a 6·8-in. gun on wheeled carriage, upon a special low truck, sunk between the bogies so as just to clear the rails;

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a 6-in. on similar truck, photographed in the act of firing when at right angles to the railway line ; and a 3·5-in. A.A. gun on an ordinary railway track, weighted for stability.

An English construction of a special low truck, as in the case of the German 6·8-in. and 6-in., is also shown by a photograph. It had the additional advantage that the whole gun platform was capable of being lowered on to the rails.

A diagram shows a post-war creation of the Americans, an E and B mounting for 14-in. guns, which embodies all their experience of the subject. This, together with their much-described 16-in. barbette guns, is the answer of American coast defence to the increasing performance of the battleship's armament.

The Piezo-Electric Effect and its Use in Wireless, by Lieut. Halder. The author gets round the course, but not without taking a toss at the first fence. He falls over the definition of piezo-electricity. " The piezo-electric properties of crystals are the peculiarity they possess under certain circumstances of displaying electrical phenomena." This statement leaves much to be desired. It is equally true of the photo-electric properties of crystals, and of their pyro-electric properties. The crux is " under certain circumstances " which should read " when subjected to distortion."

Distortion can be caused by mechanical means, producing compression or extension. Such distortion, if correctly carried out upon crystals, results in electrical charges on certain of the crystals' surfaces. This is called a " direct " piezo (compression)-electric effect. It was first noticed in Holland, in 1703, and first studied by the Curies, in 1881, the crystal used being tourmaline, which consists of triangular prisms. Distortion can also be caused by electrical means. This is called " reciprocal " piezo-electric effect.

The crystal most used in wireless is quartz. As, owing to symmetry, quartz crystals do not respond in the same way as tourmaline, it is necessary to cut quadrangular prisms out of a quartz crystal.

When such a portion of a quartz crystal is introduced into an electrical alternating field, it experiences alternate compression and extension. It can thus be set gradually into longitudinal oscillation. The amplitude of the oscillations is very small, but it can be so much increased by resonance, as to cause the quartz to splinter with violence.

It is upon resonance phenomena that the practical use of quartz in wireless depends.—(*To be continued.*)

F.A.I.

ERRATUM.

IN the List of Contents published with the *R.E. Journal* for September, 1929, page viii, the entry " Military Engineering. Vol. III—Railways, 1929," should read, " Military Engineering. Vol. VIII—Railways, 1929."

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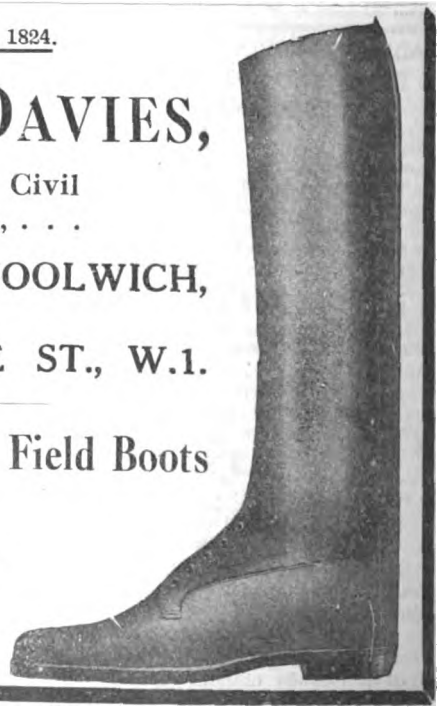

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